

SOIL SURVEY

Cass County Indiana



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In cooperation with
PURDUE UNIVERSITY AGRICULTURAL EXPERIMENT STATION

How to Use THE SOIL SURVEY REPORT

FARMERS who have worked with their soils for a long time know about the soil differences on their farms, perhaps also on the farms of their immediate neighbors. What they do not know, unless soil surveys have been made, is how nearly their soils are like those on experiment stations or on other farms, either in their State or other States, where farmers have gained experience with new or different farming practices or farm enterprises. They do not know whether higher yields obtained by farmers in other parts of their county and State are from soils like theirs or from soils so different that they could not hope to get yields as high, even if they followed the same practices. One way for farmers to avoid some of the risk and uncertainty involved in trying new production methods and new varieties of plants is to learn what kinds of soils they have so that they can compare them with the soils on which new developments have proved successful.

SOILS OF A PARTICULAR FARM

The soil map is in the jacket that contains this report. To find what soils are on any farm or other land, it is necessary first to locate this land on the map. This is easily done by finding the township in which the farm is located and by using landmarks such as roads, streams, villages, dwellings, and other features to locate the boundaries.

Each kind of soil mapped within the farm or tract is marked on the map with a symbol. For example, all the areas marked Cc are Kokomo loam. The color in which the soil area is shown on the map will be the same as the color indicated in the legend for the particular type of soil. If you want information on the Kokomo soil, turn to the section in this publication on Soil Types and Phases and find Kokomo loam. Under this heading you will find a statement of what the characteristics of this soil are, what the soil is mainly used for, and some of the uses to which it is suited.

Suppose, for instance, you wish to know how productive Kokomo loam is.

You will find the soil listed in the left-hand column of table 7. Opposite the name you can read the yields for the different crops grown on it. This table also gives estimated yields for all the other soils mapped in the county.

If, in addition, you wish to know what uses and management practices are recommended for Kokomo loam, read what is said about this soil in the section on Soil Types and Phases. Refer also to the section headed Management of the Soils of Cass County, where the soils suited to the same uses and management practices are grouped together.

SOILS OF THE COUNTY AS A WHOLE

A general idea of the soils of the county is given in the introductory part of the section on Soils, which tells about the principal kinds of soils, where they are found, and how they are related to one another. After reading this section, study the soil map and notice how the different kinds of soils tend to be arranged in different parts of the county. These patterns are likely to be associated with well-recognized differences in type of farming, land use, and land-use problems.

A newcomer to the county, especially if he considers purchasing a farm, will want to know about the climate; the types and sizes of farms; the principal farm products and how they are marketed; the kind and conditions of farm tenure, including tenancy; availability of schools, churches, roads, railroads, electric services, and water supplies; the industries of the county; and cities, villages, and population characteristics. Information about all these will be found in the section on General Nature of the Area and in the section on Agriculture.

Those interested in how the soils of the county were formed and how they are related to the great soils groups of the world should read the section on Morphology and Genesis of Soils.

This publication on the soil survey of Cass County, Indiana, is a cooperative contribution from the—

SOIL CONSERVATION SERVICE

and the

PURDUE UNIVERSITY AGRICULTURAL EXPERIMENT STATION

SOIL SURVEY OF CASS COUNTY, INDIANA¹

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United States Department of Agriculture in cooperation with the
Purdue University Agricultural Experiment Station

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¹ Report written by O. C. Rogers.

² Field work was done while Soil Survey was part of the Bureau of Plant Industry, Soils and Agricultural Engineering. Soil Survey was transferred to the Soil Conservation Service on November 15, 1952.

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CASS COUNTY is located in the north-central part of Indiana. It was settled by families from the eastern and southeastern States soon after the Federal Government obtained the area from the Indians. The county was first organized April 13, 1829. The heavy growth of forest was cleared by the first settlers to make way for crops. Corn, wheat, potatoes, and other vegetables were grown. The most important changes have been in the introduction of alfalfa and soybeans, and the growing of sweet corn, tomatoes, and other vegetables commercially. Corn, oats, wheat, and hay are the principal crops. The raising of livestock and dairying are important sources of farm income. The county is well supplied with sand, gravel, and limestone for building construction, for roads, and for agricultural purposes. To provide a basis for the best agricultural uses of the land a cooperative soil survey was made by the United States Department of Agriculture and the Purdue University Agricultural Experiment Station. Field work was completed in 1939, and, unless otherwise specifically indicated, all statements in this report refer to conditions in the county at that time.

GENERAL NATURE OF THE AREA

LOCATION AND EXTENT

Cass County covers about 415 square miles, or 265,600 acres. Logansport, the county seat, is 70 miles north of Indianapolis, the State capital; 65 miles south of South Bend; and 35 miles northeast of Lafayette, the location of the Purdue University Agricultural Experiment Station (fig. 1).

PHYSIOGRAPHY, RELIEF, AND DRAINAGE

All the counties of Indiana are within the great Interior Plains, a major physiographic division of the United States.³

³ FENNEMAN, NEVIN M. *PHYSIOGRAPHY OF EASTERN UNITED STATES*. 714 pp. illus. 1938.

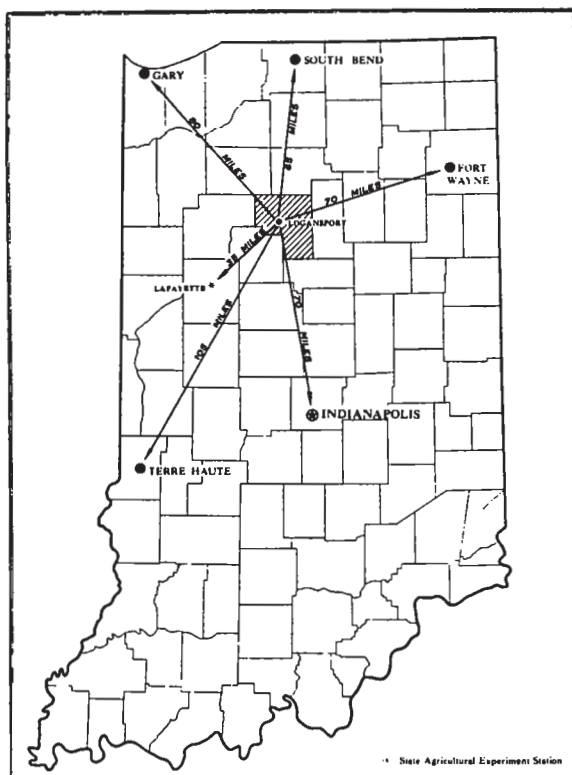


FIGURE 1.—Location of Cass County in Indiana.

Two physiographic regions occur in Cass County (fig. 2): (1) Tipton-Till Plain, and (2) Northern Moraine and Lake Region⁴ which is further divided into the Steuben Morainial Lake section and the Kankakee Lacustrine section.

The Tipton Till Plain occupies the area of the county south of the Wabash River. It is essentially a smooth to gently undulating plain that has been only slightly modified by stream dissection, except where adjacent to the Wabash River and Pipe Creek and to a lesser extent where adjacent to the smaller streams. Dissection along the Wabash River valley is pronounced and extends unevenly for a maximum distance of one-half mile from the valley.

That part of the county north of the Wabash River is located in the Northern Moraine and Lake Region. The Steuben Morainial Lake Section occupies over three-fourths of this part. Here the topography is rolling to morainic with few basins. It is the southwestern extension of the morainic area in which a kame-kettle type of topography is characteristic. The glacial drift varies in depth from a few feet to several hundred feet and consists of both assorted and unsorted material. Sandy areas, having a rolling to dunelike topography, are rather extensive in the northeastern part of the county.

⁴ LOGAN, W. N., CUMINGS, E. R., MALOTT, C. A., VISHNER, S. S., TUCKER, W. M., and REEVES, J. R. HANDBOOK OF INDIANA GEOLOGY. Ind. Dept. Conserv. Pub. 21, pp. 66-104, illus. 1922.

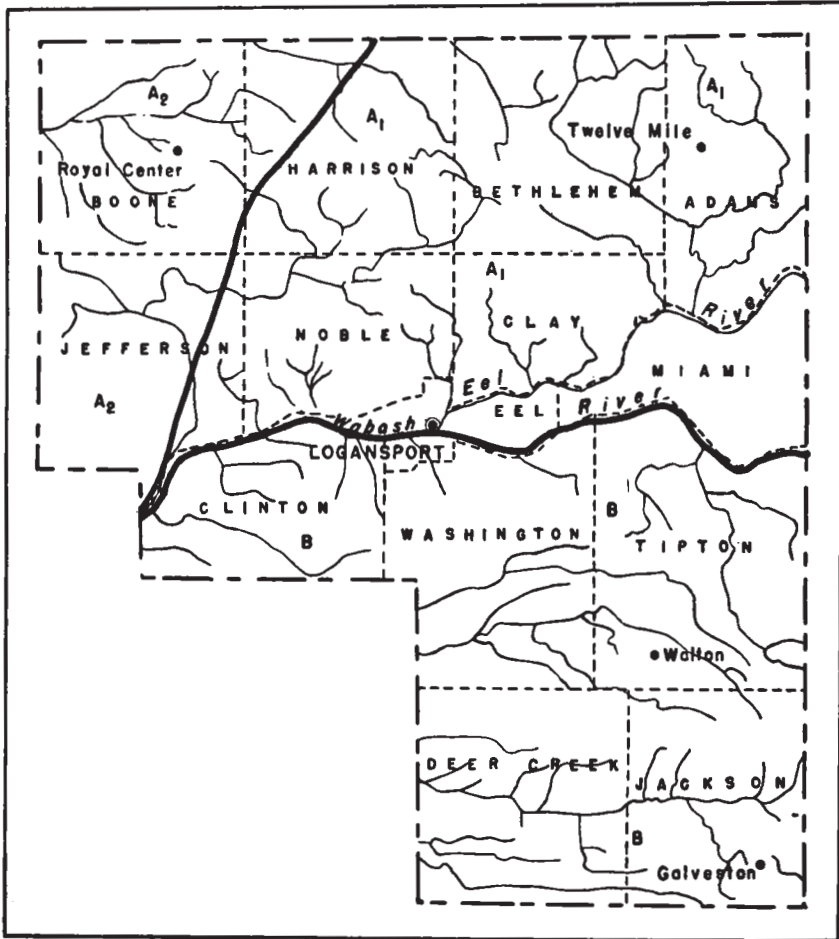


FIGURE 2.—A₁, Steuben morainial Lake section; A₂, Kankakee Lacustrine section; B, Tipton Till plain.

The depth of the sand varies from a thin veneer to several feet; this variation may be partially the result of glacial morainic deposits and some wind reworking. The southern boundary of this section is deeply dissected, particularly west of Logansport, and several streams have steep-sided valleys. Erosion is severe near these valleys.

The extreme western part of the county north of the Wabash River lies in the Kankakee Lacustrine section. This is an area of glaciofluvial deposits of gravel and sand, and minor quantities of silt and clay. Wind-deposited sands are superimposed over a considerable portion of the area. The thickness of the sandy deposits varies from a few feet to 20 feet or more. Sand dunes are scattered over this section.

Rather extensive glaciofluvial terraces, occupying different levels, occur in the valleys of the Wabash and the Eel Rivers and to a lesser extent in the valleys of the smaller streams of the county. They are composed of assorted gravel and sand and minor quantities of silt and

clay. Alluvial material, consisting of silt, sand, clay, and gravel, is somewhat extensive along the Wabash and the Eel Rivers, but the occurrence along the smaller streams is restricted.

Abundant geologic evidence indicates that Cass County, as well as about three-fourths of Indiana, was covered more than once by great sheets of glacial ice, comparable to those that now cover Antarctica and Greenland. The ice sheets were formed thousands of years ago from accumulated snows, and they spread in all directions from several centers in what is now Canada. The last ice sheet, of Wisconsin age, extended irregularly southward beyond Logansport, Richmond, and Lafayette, Indiana, covering all of Cass County.

The limit of the extension of the ice at any one time was determined by the rate of melting at its outer edge in relation to the rate of its forward movement. In unusually warm periods, the ice front would retreat, and in colder periods it would advance farther than it melted.

As the ice moved slowly over the surface of the land it destroyed all higher forms of life in its path and ground and pulverized the rock beneath it. Some rocks and ground-up material were carried hundreds of miles on, in, or under the ice, to be deposited far from their source when the ice melted. Many of the boulders in this county are completely unlike the bedrock beneath them; instead they resemble the bedrock several hundred miles to the north.

The pulverizing action of the ice ground many of the rocks into fine fragments that could be easily converted into soil by weathering processes and by the activities of plants and animals. In those places where the rate of melting about equaled the rate of the forward movement of the ice, the glacial debris piled up to form hilly moraines largely of unassorted materials. When the melting of the ice was much more rapid than the forward movement, the load of ground-up rocks and minerals was deposited to form an unassorted mixture of silt, clay, rock flour, pebbles, and rock fragments. Land that was originally level or nearly so was made undulating or billowy in many places. A deposit of this sort is a kind of ground moraine or till plain. The unassorted material in the hilly moraines and ground moraines is known technically as glacial till.

During periods of warm weather, the rapidly melting ice or glaciers made great floods, which spread over the lowlands to form lakes and rivers. In summer many of the rivers were several miles wide near the front of the ice, but in winter or colder periods they diminished greatly or disappeared. The water from the glaciers carried a large quantity of sediments ranging in size from the finest silt and clay to large cobblestones. The cobblestones and pebbles were deposited by swift water, the sand by more slowly moving water, and the silt and clay by the relatively quiet waters of lakes. These deposits are laid down as broad, nearly level outwash plains or as terraces within the valleys of the present streams. Commonly associated with hilly moraines are kames or hilly deposits of imperfectly assorted water-laid gravel and sand. The stratified and assorted deposits laid down by more or less rapidly flowing glacial water are known collectively as glaciofluvial deposits, and those laid down in lakes or in quiet water are known as lacustrine deposits.

Much of the glacial drift in Cass County includes such a wide variety of minerals that the reserves of plant nutrients are very high;

but some of the deposits are so sandy and contain such a high percentage of quartz that soils developed from them are droughty and unproductive. A small part of the glacial till contains such a high proportion of clay that the soils developed on it are limited in their suitability for some crops.

The maximum altitude occurs near Metea in Bethlehem Township and is 825 feet above sea level. The minimum altitude of 550 feet above sea level occurs in the southwestern part of the county where the Wabash River leaves the county. The maximum relief in the county is 275 feet, and the maximum local relief is 120 feet, which occurs along the Wabash River valley. The average elevation of the county is 725 feet. The elevation at Logansport is 596 feet; at Clymers, 732 feet; at Walton, 775 feet; at Royal Center, 752 feet; and at Hoovers, 679 feet.⁵

Cass County is drained by the Wabash and the Eel Rivers and their tributaries, except for a small area in the northern part of the county, which is drained by tributaries to the Tippecanoe River (fig. 2).

The Wabash River enters the county from the east at about the central part of the county, flows west past Logansport to Georgetown, and then turns sharply to the southwest and leaves the county. The Eel River enters the county from the east, about 6½ miles south of the north county line. It flows southwest and unites with the Wabash River at Logansport. Pipe Creek enters the county about 2 miles south of the Wabash River and unites with that river about 2½ miles west of the east county line. Rock and Deer Creeks drain most of the county south of the Wabash River. They flow west and enter the Wabash River in Carroll County. Twelve Mile Creek drains the northeastern part of the county and enters the Eel River about 4 miles west of the east county line. Crooked Creek drains a large part of the central and western parts of the county north of the Wabash River, entering the river about 4 miles east of the west county line.

The greater part of Boone township, the northern half of Harrison township, and the northwestern part of Bethlehem township are drained by small streams that flow west or northwest and are tributary to the Tippecanoe River.

CLIMATE

The climate of Cass County is humid, temperate, and continental. There are wide variations in temperature during the year, from an average annual temperature of 25.2° F. for January to an average annual temperature of 75.4° for July. The rainfall is usually sufficiently well distributed throughout the growing season to insure the growth of common crops. Seasons of drought, however, do occur and yields are seriously affected. But total crop failures are practically unknown.

The length of the growing season as recorded by the United States Weather Bureau Station at Logansport is 167 days; from April 27, the average date of the last killing frost in spring, to October 11, the date of the first killing frost in fall. Logansport is situated at the junction of the Wabash and the Eel Rivers where air drainage is not so good as on the higher and undulating uplands. Because of the poor air drainage and shorter frost-free periods, crops grown on the low terraces and bottoms occasionally fail to mature.

⁵ Elevations from U. S. Geological Survey.

More than 57 percent of the rainfall during the year occurs in the growing season, from April to September, inclusive. Normal rainfall in July and August is very essential to corn, and lack of it greatly decreases the yield.

The average yearly snowfall at Logansport is 22.4 inches. This is usually sufficient to protect clovers, wheat, and rye from winter-killing, but occasionally these crops suffer from a lack of this protective covering. Alternate freezing and thawing may seriously injure alfalfa and clover when they are not covered by snow. High wind velocities are seldom reached, and tornadoes are rare.

The normal monthly, seasonal, and annual temperature and precipitation at Logansport are given in table 1.

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation at Logansport, Cass County, Ind.*

[ELEVATION, 590 FEET]

Month	Temperature ¹			Precipitation ²			
	Average	Absolute maximum	Absolute minimum	Average	Total for the driest year	Total for the wettest year	Average snowfall
	° F.	° F.	° F.	Inches	Inches	Inches	Inches
December----	29. 2	70	-15	2. 51	4. 54	4. 34	4. 7
January-----	25. 2	69	-25	2. 41	. 45	6. 60	6. 3
February-----	26. 3	69	-24	2. 32	1. 37	3. 50	5. 7
Winter-----	26. 9	70	-25	7. 24	6. 36	14. 44	16. 7
March-----	37. 8	87	-3	2. 93	. 95	1. 80	4. 2
April-----	50. 8	91	15	3. 36	. 88	2. 45	0. 4
May-----	62. 2	101	28	4. 15	2. 38	7. 50	(³)
Spring-----	50. 2	101	-3	10. 44	4. 21	11. 75	4. 6
June-----	71. 2	103	35	3. 73	1. 62	12. 16	0
July-----	75. 4	106	43	3. 14	. 62	5. 13	0
August-----	72. 8	105	41	3. 17	2. 00	1. 76	0
Summer-----	73. 1	106	35	10. 04	4. 24	19. 05	0
September----	65. 8	102	30	3. 52	3. 50	1. 43	0
October-----	53. 2	92	18	2. 68	2. 50	6. 55	. 1
November----	40. 6	80	3	2. 98	3. 77	1. 35	1. 0
Fall-----	53. 2	102	3	9. 18	9. 77	9. 33	1. 1
Year-----	50. 9	106	-25	36. 90	⁴ 24. 58	⁵ 54. 57	22. 4

¹ Average temperature based on a 35-year record, 1896 to 1930; highest and lowest temperatures from a 35-year record, 1896 to 1930.

² Average precipitation based on a 73-year record, 1880 to 1952; wettest and driest years based on a 63-year record, 1890 to 1952; snowfall on a 35-year record, 1896 to 1930.

³ Trace.

⁴ In 1856.

⁵ In 1949.

WATER SUPPLY

Water supplies for both people and livestock are obtained from wells drilled into the unconsolidated silt, sand, clay, and gravel, or drilled into the underlying bedrock. The depth of wells driven into the glacial drift material varies from 20 to 100 feet or more and depends upon the presence of strata of sand or gravel. In the stream valleys, water is obtained from driven wells at depths of 15 to 25 feet. Wells are driven into the underlying limestone bedrock in the areas adjacent to the Wabash River, and an adequate supply of good quality water is usually obtained. Water for livestock is also obtained from the various rivers and streams in the county.

Lake Cicott is in the western part, and a few other small lakes or ponds occur in the county. Lake Cicott and the larger streams and rivers are well stocked with fish.

VEGETATION

Before the coming of the white settlers much of Cass County was covered with a heavy growth of forest. The varieties of trees on the well-drained areas included black, white, and red oaks, hickory, hard and soft maples, black walnut, butternut, ash, hackberry, and elm. The lower lying areas and bottoms, where drainage was imperfect, sustained a growth of elm, beech, sycamore, swamp oak, swamp ash, soft maple, linden, and cottonwood.

The swamps and poorly drained areas varied greatly in vegetal cover, depending largely upon the degree of wetness and the quality of organic material. The open muck areas supported a growth of sedges, bluejoints, northern wildrice (*Zizania aquatica*) and water lilies (*Nymphaea tuberosa*), fringed with a growth of swamp oak, willow, buttonbush, and swamp ash. Areas having somewhat better drainage, where the water table was at or above the surface for only a small part of the year, contained swamp oak, willow, sycamore, elm, and ash, and a sparse growth of wild rose, huckleberry, and briers.

The trees of the forests now in Cass County are mostly reproductions of the original species. On the sandier areas the several varieties of oak predominate. Much of the area has an undergrowth of papaw, wild rose, and briers, with some Kentucky bluegrass (*Poa pratensis*). The well-drained areas of muck, which are not cropped, support a good stand of Kentucky bluegrass, whereas the wetter areas contain sedges, buttonbush, and bluejoints, and a somewhat scattered growth of oak, willow, ash, and sycamore.

ORGANIZATION AND POPULATION

In the early part of the last century the Miami Indians occupied all of the territory south of the Wabash River now included in Cass County. All of the present county area lying north of this river was occupied by the Pottawatomes. Title to the area was obtained from the Indians by the Federal Government about 1826 and the Indians were moved from this vicinity.

The first white settlement in Cass County was made by Alexander Chamberlain near the present site of Logansport. The county was first organized April 13, 1829, and included a much larger area than at

present. The present boundary was established in 1852. Settlement progressed gradually within the county, and by 1850 there was a population of 11,021.

The Michigan Road, a highway 100 feet wide, from the Ohio River through Indianapolis, Logansport, and South Bend, to Lake Michigan was completed and opened in 1834. This provided an excellent means of transportation, both for immigration into the county and for produce into and out of the county.

The Wabash and Erie Canal was in operation between Fort Wayne and Logansport in 1838, and was extended westward in 1839. It was completed to the Wabash River at a point south of Terre Haute, Indiana, in 1843. It continued to operate until 1876. Because Logansport was situated at the junction of Michigan Road and the Wabash and Erie Canal, the trade within the county was greatly increased and rapid settlement made possible.

The early settlers came from the eastern and southeastern States and were of mixed national origin; no one national ancestry predominated.

Logansport, the county seat, with a population of 21,031 in 1950, is the largest city. It is located at the junction of the Wabash and the Eel Rivers and is the principal trading center for the county. Other trading centers are Royal Center, Twelve Mile, Lucerne, Young America, Galveston, Walton, New Waverly, Metea, Hoovers, Georgetown, Lincoln, Kenneth, Clymers, and Lake Cicott.

INDUSTRIES

Cass County is well supplied with sand, gravel, and limestone for building construction, for roads, and for agricultural purposes. At Kenneth, 6 miles west of Logansport, a limestone quarry and crushing plant are operated for the production of blast furnace flux, foundry and cupola flux, railroad ballast, and crushed limestone for road and building construction. An additional byproduct in recent years is agricultural limestone for use on farmland. A large limestone quarry 3 miles east of Logansport produces stone for highways, railroad ballast, and sewage disposal trickling filter beds. Flux and rock wool for general building construction, and chemical lime, quick and hydrated lime, and ground limestone for agricultural use are also produced.

A large gravel and sand plant is located 7 miles northwest of Logansport. It produces sand, gravel, and crushed stone, which is used principally for railroad ballast and road-building material. A plant at Lake Cicott produces sand and markets it in large quantities.

Manufacturing establishments dealing in fire-fighting apparatus, springs, furniture, buttons, and ladies apparel are located in Logansport. Shops of the Pennsylvania Railroad are also located in Logansport.

TRANSPORTATION AND HIGHWAYS

Several lines of the Pennsylvania Railroad; the Wabash Railroad, and the Chesapeake and Ohio Railway serve practically all parts of the county. The building of these railroads was important in the agricultural development of the county. After the abandonment of the Wabash and Erie Canal in 1876, practically all of the livestock, livestock products, and grain were transported to markets by railroad.

This continued until the coming of motor trucks and hard-surfaced roads.

A network of hard-surfaced highways—United States Highways Nos. 24 and 35—and five State highways traverse the county. The establishment of this system of roads, together with the increased use of motor trucks, has changed the marketing methods of the county. Practically all of the livestock, livestock products, and farm crops are marketed by trucks. Bus service follows the major highways.

SCHOOLS, CHURCHES, AND OTHER PUBLIC FACILITIES

A system of consolidated schools is maintained within the county. Numerous churches located throughout the county serve the needs of the various religious groups. Free mail delivery service is available to all districts, and telephone service is readily available to most areas of the county. The 1950 Federal census reports 1,388 farms served by telephone.

Electric service is available to a large part of the county. In 1950, of the 1,993 farm dwellings with electricity, 1,983 received it from a power line.

AGRICULTURE

Agriculture began with the coming of the first settlers. The well-drained upland areas were first selected for homesites, and trees were felled to make way for the crops. Corn, wheat, potatoes, and other vegetable crops were grown principally for home consumption. Wheat and corn were ground at local mills into flour and meal. Wild game was plentiful and was an important source of meat for the pioneers. The influx of settlers was steady, and the increase in population caused an expansion of agriculture.

Gradually the more desirable dark-colored areas were drained and put into agricultural production. As a result more livestock were raised to consume the surplus crops. Corn, wheat, oats, hay, vegetables, and orchard crops were grown in the county 50 years ago much the same as at present. The most important changes have been the introduction of alfalfa and soybeans, and the growing of sweet corn, tomatoes, and other vegetables commercially.

The building of the Wabash and Erie Canal and the Michigan Road through the county stimulated agriculture at a comparatively early date. As a result a more diversified system of farming developed, both to supply the demands of the rapidly growing population of Logansport and the enlarged market outside the county.

The building of the railroads through the county again encouraged expansion of agriculture and led to a more diversified system of farming, in which the raising of livestock and dairying were important. The construction of hard-surfaced highways and good gravel roads throughout most of the county, together with the advent of the motor truck, has opened up new markets for dairy and poultry products, vegetables, and other farm crops and products.

CROPS

The acreage of the principal crops grown in Cass County, Ind., in stated years, is given in table 2.

TABLE 2.—*Acreage of the principal crops and number of bearing fruit trees and grapevines in Cass County, Ind., for stated years*

Crop	1919	1929	1939	1949
	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>
Corn for grain.....	56, 926	54, 936	57, 022	62, 567
Oats threshed.....	23, 314	30, 174	16, 067	24, 710
Wheat threshed.....	39, 538	19, 907	16, 893	18, 956
Rye threshed.....	8, 021	2, 382	5, 897	1, 030
All hay.....	18, 569	20, 407	21, 282	21, 029
Timothy and clover, alone or mixed.....	18, 075	16, 342	8, 369	13, 107
Alfalfa.....	61	550	4, 871	6, 844
Other cultivated grasses.....	63	88	118	549
Grains and annual legumes cut for hay.....	370	3, 427	7, 924	529
Coarse forage, including silage crops.....	15, 301	2, 940	2, 605	5, 942
Soybeans.....	(¹)	3, 576	17, 424	15, 059
Potatoes, white.....	804	915	588	140
All other vegetables harvested for sale.....	362	497	1, 097	748
Clover and other grass seeds.....	(¹)	7, 229	2, 623	1, 918
	<i>Number ²</i>	<i>Number ²</i>	<i>Number ²</i>	<i>Number ²</i>
Apple.....trees.....	32, 657	24, 141	11, 872	6, 751
Peach.....do.....	4, 102	4, 839	1, 897	891
Cherry.....do.....	4, 565	2, 126	1, 298	587
Pear.....do.....	2, 456	2, 092	978	390
Plum and prune.....do.....	1, 398	1, 015	916	219
Grapevines.....	2, 721	3, 309	2, 992	953

¹ Not reported.² Number in census year, which is 1 year later than crop year given at head of column.

CEREAL AND GRAIN CROPS

The acreage used for cereal crops reached its peak in 1919, when 127,799 acres were used for corn, wheat, oats, and rye. This was 20,536 acres more than the acreage in these cereals in 1949.

CORN

Corn is the most important crop grown in the county, both in total acreage and in value. It is the basic feed crop in the livestock system of farming that prevails in the greater part of the county.

The greatest acreage and the highest yields obtained are on areas of Wisconsin drift where there is a dominance of the dark-colored Brookston soils; on the dark-colored Westland and Abington soils of the glaciofluvial plains and terraces; on Millsdale silty clay loam of the terraces; on Nyona and Lear soils of the prairie region; and on Genesee and Eel soils of the first bottoms.

Land used for corn is plowed either in fall or spring, depending upon weather conditions and soil type. Fall plowing promotes erosion, especially on the more rolling areas, and consequently the greater part of cornland on the rolling areas is plowed in spring. The ground is thoroughly disked and smoothed with either a harrow or a cultipacker before planting. A large number of farmers use mechanical equipment for plowing and preparing the seedbed, and some use 2- or 4-row corn planters powered by tractors. Corn is planted in normal seasons from May 10 to June 1. Over 90 percent of the seed corn planted is hybrid. There has been an increase in

the fertilization of corn in recent years. The more popular analyses are 3-12-12, 4-16-16, 0-12-12, 0-10-10, and 0-20-20.

Methods of harvesting corn vary with the individual farm requirements. It may be husked in the field, cut for silage, cut and shocked in the field, or hogged off. The greatest acreage is at present harvested in the field, either by hand or with mechanical pickers.

The greater part of the corn grown within the county is fed to livestock on the farms. The surplus is either sold to local elevators, where it is shelled and shipped by train to Chicago, or it is sold to livestock feeders from surrounding areas and transported by motor truck.

WHEAT

In 1949, 18,956 acres were used for wheat, compared to 39,538 acres in 1919. This reduction has been due to the increase in the acreage used for soybeans and vegetables.

Wheat may follow corn, soybeans, or oats in the rotation system, or may be sown on land where legumes have failed. When it follows corn, the wheat is drilled between the corn rows. If the corn has been cut for ensilage or fodder, the land is disked and smoothed with a drag or harrow before the seed is planted. When wheat follows soybeans, it is usually drilled without any previous working of the soil. When it follows other crops, the seedbed is prepared by plowing and disking. Seeding takes place in September, usually after the fly-free date (date when the hessian fly ceases to be a danger) as given by the Purdue University Agricultural Experiment Station.

Wheat ripens in the latter part of June or the early part of July. It is either cut with a grain binder and placed in shocks to be threshed later, or is cut and threshed with a grain combine. Wheat is marketed largely through local elevators as a cash crop. Relatively small quantities are retained on the farm for seed, and in years when the supply of other feeds is reduced, it is ground and fed to hogs, dairy cows, and other livestock.

Wheat is grown throughout the county, but it is probably better adapted to the well-drained light-colored loams and silt loams, as the Miami, Russell, and Milton soils. When grown on the dark-colored soils, as Brookston, Kokomo, and Westland, there is danger of too heavy growth of straw and improper ripening of the grain, unless larger quantities of phosphate fertilizers are used. Imperfect drainage conditions are injurious to wheat, and yields are occasionally substantially reduced by heaving or by drowning out.

RYE

Rye has always been a minor grain crop in the county. Seeding and harvesting are essentially the same as for wheat, although rye is usually seeded somewhat earlier in fall. Rye is often pastured for a few weeks in spring, before other pasture is available.

OATS

Oats follow corn, wheat, or soybeans in the crop rotation system, or they may be sown where alfalfa or other legumes have been winter-killed. They are seeded late in March or in April, the date of seeding depending upon weather conditions. Yields are, in general, greater

when seeding is early, but prolonged, hot, dry weather during any part of the growing and ripening season will materially reduce the yield. When oats follow corn, wheat, or soybeans, the land is disked, or in some instances plowed, and the seed is either drilled or sown broadcast and disked in. When they follow legumes, the land is usually plowed before seeding.

Harvesting takes place late in July or August; methods are similar to those used in the harvesting of wheat. Oats are either marketed through elevators or are retained on the farm and used as livestock feed. In years of reduced feed supplies, a large part of the crop grown is ground and mixed with other feeds for use on the farm. Oats, as well as other small grains, are not always profitable but are considered necessary in the crop rotation system, as these crops serve as a nurse crop for clovers and alfalfa.

SOYBEANS

The acreage of soybeans has increased very rapidly in recent years. They are used both for hay and for seed. The increased acreage has been largely the result of the growing demand for soybeans as a source of oil and the attractive price. Soybeans are planted late in May or in June, and follow corn, oats, or wheat in the rotation, or they may be grown on land where other legumes have been winterkilled. A seedbed is prepared as for corn, and thorough weed control both before and after planting is essential for the success of the beans. Seed should be inoculated until the soil in the producing field carries abundant inoculation. Soybeans are used both for hay and for beans. For maximum feeding value of the hay, the seed should be well developed in the pod before harvest. Harvesting for seed is accomplished almost entirely with combines. Most of the seed is marketed through elevators as a cash crop, although some is retained on the farm for seed and for livestock feed.

MINOR CEREAL AND GRAIN CROPS

Other cereal and grain crops grown to a limited extent in Cass County include barley, buckwheat, and sorghum. The acreage of these crops has never been large, and they usually do not have a place in the crop rotation systems. They are grown, however, as an emergency crop on areas where some other crop has failed. Sorghum is grown for silage and for molasses in various parts of the county, but barley and buckwheat are usually limited to the northern part. Cowpeas are occasionally grown, both for hay and for seed.

HAY CROPS

There has been a rather uniform acreage in hay crops for the past 50 years, but a radical change has occurred in the kinds of hay grown. Timothy and clover alone have given way to alfalfa, sweetclover, and a few other less important hay crops. The most significant changes were a reduction from 6,692 acres of clover grown alone in 1930 to a quantity too insignificant to report in 1949 and the increase in the acreage of alfalfa. The rapid increase in alfalfa acreage has been due largely to the more general knowledge that liming of most of the soils is a necessary prerequisite for the success of alfalfa, and to the appreciation of its feeding qualities, both as pasture and hay.

Alfalfa is either seeded in fall with or without a nurse crop, or it is seeded in wheat or rye or with oats in spring. A good seedbed is prepared when seeding takes place in fall, and the soil is packed with a cultipacker or roller to maintain good moisture conditions. A large proportion of the soils of the county need to be limed for the success of alfalfa, and the majority of farmers do not attempt to grow it until sufficient lime, usually in the form of ground limestone, is applied to bring the reaction of the soil to pH 6.0 or higher. Alfalfa is not so well adapted to the acid soils in the northwestern part of the county, and only a small part of the total acreage is used for it in that part of the county. It is well adapted to soils of the Wisconsin glacial drift regions after sufficient lime is applied, and to the alluvial soils. Inoculation of the seed is essential for the most successful growth and for the storage of nitrogen on the roots of the plants. Alfalfa is used for both pasture and hay, the use depending largely on the type and quantity of livestock on the farm.

Sweetclover is grown in Cass County primarily as a soil improvement crop, but it also may be used as pasture or grown as a seed crop. Like alfalfa, it requires a soil with a reaction of pH 6.0 or higher for successful growth, and seed inoculation is essential, both to insure proper growth and to enable the plants to store nitrogen in the soil. Most of the sweetclover is seeded in wheat or with oats in spring. It occasionally is sown as a part of a mixed pasture, which includes alfalfa, clover, timothy, and sometimes brome-grass. In some areas it is used as an intercrop in a 2-year rotation of wheat and corn or oats and corn.

The decrease in acreage used for clover in the last decade is due to the increase in alfalfa acreage, and to the more general policy of using red clover as a part of a mixture that also includes alfalfa, timothy, alsike, sweetclover, and in some instances brome-grass.

Red clover is seeded in spring in wheat or rye, or with oats. It will tolerate a higher acidity than either alfalfa or sweetclover, but for best results, sufficient lime should be applied to the soils to lower the acidity to a pH of about 6.0. Inoculation of red clover seed is necessary to insure proper growth and to enable the plants to store nitrogen in the soil. Red clover is used both for pasture and hay. It may be pastured in the early part of the season and then cut for hay. The first cutting of common red or "little red" clover is often used for hay. The crop is cut for seed in fall. Practically all of the hay is used on farms, but in years of unusually large yields, a small part may be sold to livestock farmers in adjacent areas.

Although the acreage used for timothy alone was not reported by the Federal census in 1929 and 1939, there has been a steady decrease in the acreage in recent years. Alfalfa, red clover, and other legumes have replaced it in the rotation or it is more commonly sown as part of a hay mixture that also includes alfalfa, red clover, alsike clover, and in some instances brome-grass.

Hay crops grown to a limited extent in Cass County include brome-grass, millet, Sudangrass, and rape.

Brome-grass has been used with alfalfa and other legumes, usually taking the place of timothy in the mixture where meadows stand for 2 or more years. Recent experiments by the Purdue University Agricultural Experiment Station have shown that brome-grass is equal or

superior to timothy as a pasture for cattle and hogs, and there will probably be an increase of brome grass grown in future years.

Millet, Sudangrass, and rape are usually grown as special pasture crops to supplement other pastures or as an emergency pasture when other pastures have failed.

VEGETABLES

Sweet corn, cucumbers, tomatoes, and other vegetables grown commercially are seeded in spring and early in summer and are largely grown for canning factories within the county and in adjacent counties. Current prices and weather conditions usually determine the extent of these crops. In 1949, vegetables were harvested for sale on 748 acres. The total acreage used for vegetables for home consumption is usually large and more or less constant. There were 145 acres in potatoes and sweetpotatoes, which were harvested for home use and for sale.

ROTATIONS AND FERTILIZERS

The following crop rotations are those commonly used in the regions of glacial till, south of the Wabash River, and in those areas north of the Wabash and the Eel Rivers that have a silt loam and silty clay loam texture:

1. Corn, wheat or oats, and hay including clover, alfalfa, sweetclover, or a mixture of these with timothy.
2. Corn for 2 years, wheat or oats, and 1 to 2 years of alfalfa or a mixture of alfalfa, clover, and timothy or brome grass.
3. Corn, soybeans, wheat, and mixed legumes and grasses.

The above rotations are varied to include special field and vegetable crops, and the order in the rotation is occasionally changed to meet special seasonal and feed requirements.

Rotations in common use on the glaciofluvial outwash plains and terraces are:

1. Corn, wheat, 1 or more years of alfalfa.
2. Corn, soybeans, wheat, and mixed hay.
3. Corn, soybeans, wheat, and 2 to 5 years of alfalfa.

These rotations are varied to include vegetables and special field crops and to meet seasonal requirements.

Rotations on the alluvial soils are:

1. Two or more years of corn, wheat, corn, soybeans.
2. Corn, wheat, and alfalfa or mixed hay.
3. Corn and soybeans.

The rotation that includes hay crops is largely confined to the high-bottom areas where overflow is not so great a hazard.

Rotations in use on the areas of lighter textured glacial drift that occur north of the Wabash and the Eel Rivers are somewhat similar to those in use in the areas of glacial drift south of these rivers, but corn is used less often and small grain and hay crops more often in the rotations. These soils are not so well adapted, in general, to corn as those of the river bottoms, and the relief is generally more rolling. More small grains and hay crops are therefore necessary in the rotations.

The rotation in use in the northwestern part of the county, on the strongly acid sands, usually consists of corn, wheat, and a hay crop that includes timothy and some clover and alfalfa. Because of the high acidity of these soils, it is difficult to obtain stands of alfalfa and

clover without heavy applications of lime, and the excessively drained sandy areas are too droughty for successful growing of clovers.

Use of commercial fertilizer is rather general throughout the county. Fertilizer usually is purchased ready mixed, but a few farmers do home mixing. It is purchased both cooperatively and individually, but an increasing quantity is being purchased through cooperative farm organizations. There is, at present, a trend toward the use of fertilizer of higher analyses in larger quantities an acre. It is common practice to supplement commercial fertilizers with barnyard manure. Most of this is applied to land that is to be planted to corn, although some is used as a topdressing for wheat. Most of the manure is applied to the lighter colored soils, which are deficient in nitrogen and organic matter.

The value of lime for correcting soil acidity is generally recognized, and there has been an increasing quantity used in recent years, principally in the form of ground limestone. In determining the lime requirements of a soil or soils in a given field, it is important that accurate tests be made. Probably the best procedure is to find out from the local county agricultural agent or the Purdue University Agricultural Experiment Station how to have accurate tests made.

PERMANENT PASTURES

The permanent pastures throughout the county, except the areas of strongly acid sandy soils in the northwestern part, are largely Kentucky bluegrass. They occur as relatively small fields on a large number of farms. The imperfectly drained soils of the bottoms and cleared areas of the steeper slopes probably have a larger percentage in bluegrass than any other areas in the county. The permanent pasture on the strongly acid soils includes broomsedge and various weeds, and a small quantity of Kentucky bluegrass. Fertilization of permanent pastures is not a common practice in the county, although most of them could be improved by liming and fertilizing the areas, control of weeds, and more careful grazing practices.

LIVESTOCK AND LIVESTOCK PRODUCTS

The raising of livestock has been a very important source of farm income in Cass County for the past 60 years and is the medium through which a large part of the farm crops are marketed.

The number of livestock on farms in stated years is given in table 3.

TABLE 3.—*Number of livestock on farms in Cass County, Ind., in stated years*

Livestock	1920	1930	1940	1950
	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>
Horses.....	9, 253	6, 055	¹ 4, 369	876
Mules.....	840	751	¹ 568	56
Cattle.....	23, 471	21, 744	¹ 23, 830	28, 694
Swine.....	56, 108	59, 373	² 41, 685	82, 474
Sheep.....	8, 751	16, 145	³ 7, 072	8, 435
Chickens.....	206, 910	¹ 175, 424	¹ 147, 310	³ 167, 965
Beehives.....	896	1, 071	369	429

¹ Over 3 months old.

² Over 4 months old.

³ Over 6 months old.

CATTLE

Dairying is an important livestock enterprise in the county. In 1950 there were 8,839 cows kept mainly for milk production. Two types of dairying—specialized dairying and general dairying—are followed.

Specialized dairying occurs near Logansport and some of the larger towns of the county. These dairies produce sweet milk and cream for the nearby communities. Most of the sweet milk and cream is bottled and sold both to retail and wholesale customers. High-producing herds, consisting mainly of purebred Guernseys, Jerseys, and Holstein-Friesians, and a few consisting of high-grade mixed breeds, are used.

General dairying is followed on farms that sell their dairy products, largely whole sweet milk or sweet cream, to creameries. Trucks call at the farm daily for these products and deliver them to the creameries in this and neighboring counties. Most of the herds consist of good-grade cows.

There were 184 dairy farms in 1950, or slightly over 9 percent of the total farms in the county. The major part of the feed for dairy cattle is grown on the farm, and includes corn, oats, other grains, and hay. There is, however, a large quantity of commercial supplements used, especially by the larger dairies.

Beef cattle are distributed throughout the county, but the greater number are maintained on farms south of the Wabash River.

SWINE

The raising of swine is an important industry in the county, especially in the southern part, where corn production is high. The abundance of corn and pasture grown in the county contributes greatly to the large number of swine grown. The principal breeds include Duroc-Jersey, Chester White, Poland China, and Hampshire, or crosses of these breeds. The larger part of the feed for hogs, mainly corn and legume pasture, is grown on the farm. It is supplemented by commercial feeds on most farms. Swine are marketed at Indianapolis, Chicago, and at local markets, and practically all are transported in motor trucks.

SHEEP

Sheep are distributed throughout the county, and generally the flocks are small. Most of the sheep are raised on the farm, but a few farmers buy feeder sheep or lambs and fatten them. About half as many sheep were kept in 1950 as were kept in 1930. They are marketed principally in Indianapolis and Chicago.

POULTRY

Cass County is an important poultry-producing area. In 1949, 1,657,545 dozen chicken eggs were sold. Almost every farm has from a few dozen to over 100 head of laying hens, and several farms that specialize in poultry have several hundred head. There were 92 poultry farms in the county in 1950. Those farms specializing in poultry have principally Leghorn and other high-producing breeds, and the other farms have a wide variety of both mixed and purebreds. The greater part of the poultry and poultry products is marketed

locally to local dealers or to dealers who call at the farm for the produce. A majority of the specialized farms, however, ship to outside markets and usually obtain a premium price for their products.

The total number of poultry, other than chickens, raised in the county is never large, and includes turkeys, geese, ducks, and guineas. In 1949 there were 8,566 turkeys and 592 ducks raised.

WORK STOCK

There has been a steady decline in the number of horses and mules on farms in Cass County in the past 20 years. The increased use of mechanized farm implements has caused the decrease in work stock. Part of the work stock is raised on the farm and part purchased from adjacent areas. Practically all of the feed is grown on the farm and is principally oats and hay.

TYPES OF FARMS

In 1950 farms classified by type are livestock other than dairy and poultry, 846; general, 383; miscellaneous and unclassified, 307; field-crop other than vegetable and fruit-and-nut, 199; dairy, 184; and poultry, 92.

LAND USE

In 1940, 91.1 percent of the county was in farms—slightly less than the high of 92.5 percent in farms in 1950.

The acreage in farms and farmland according to the various uses is as follows:

	1950 (Acres)
Cropland harvested.....	148, 425
Cropland used only for pasture.....	31, 225
Cropland not harvested and not pastured.....	8, 110
Woodland pastured.....	19, 002
Woodland not pastured.....	8, 080
Other pasture (not cropland and not woodland).....	14, 332
Other land (house lots, roads, wasteland, etc.).....	16, 521
All land in farms.....	245, 695

The larger areas of woodland are on the steeper sloping areas along the valleys of the Wabash and the Eel Rivers and the smaller streams, and on the sandy areas in the northwestern part of the county.

The number of farms and the farm acreage, classified by size of farm in 1950, are as follows: 146 farms, under 10 acres; 446, 10 to 49; 400, 50 to 99; 722, 100 to 219; 276, 220 to 499; and 21 farms, 500 acres or more.

There were 2,011 farms in the county in 1950, which was a decrease of 191 from the number in 1940; 854 farms, or 42 percent, range from 70 to 179 acres in size.

FARM TENURE

The percentage of farms operated by owners, tenants, and managers in Cass County, Ind., in stated years is given in table 4.

Of the 515 farms operated by tenants in 1950, 444, or slightly more than 86 percent, were rented on the share-cash and share tenants and croppers basis. The tenant receives from one-third to one-half of the total crop produced and some provision is made for living privileges. Where livestock is produced the same variations exist.

TABLE 4.—*Percentage of farms operated by owners, tenants, and managers in Cass County, Ind., in stated years*

Year	Percentage of farms operated by—		
	Owners	Tenants	Managers
1920.....	59. 2	39. 5	1. 3
1930.....	62. 3	37. 2	. 5
1940.....	66. 8	32. 8	. 4
1950.....	74. 2	25. 6	. 2

Only 23, or about 5 percent, of the farms operated by tenants were rented on the cash basis. When the land is rented for cash, the price an acre varies with the productiveness of the soil, farm improvements and facilities, and current economic conditions.

FARM INVESTMENTS

In 1950, according to census reports, 1,453 farms had 2,317 tractors; 633 farms had 686 trucks; and 1,797 farms had 2,163 automobiles.

Extra farm labor is extensively used during the planting and harvesting seasons. Labor is hired on a weekly, monthly, or yearly basis on the larger farms, and housing facilities, various food, and other incidental subsistence items are often included in the contract.

SOILS

The soils of Cass County represent a very wide variation in color, natural drainage conditions, fertility, consistence, slope, and susceptibility to erosion. These characteristics are very significant in determining soil productivity, and one or more of them are often the limiting factors in the agricultural use made of the various soil types and phases.

Soil types, embodying different combinations of the characteristics mentioned above, are often closely associated, and a field unit often includes a wide range of soil conditions. This fact makes it very difficult to apply individual systems of crop rotation, fertilization, and other soil improvements to the individual soils; therefore more general methods of management are used.

The soils range in surface texture from fine sand to silty clay loam and in color from light gray in the poorly drained soils of the uplands and terraces to very dark brownish gray or nearly black in the depressional soils of the uplands and terraces and in the organic soils.

The color of the subsoil ranges from yellowish brown to gray or mottled gray, yellow, and brown, or dark gray. The texture of the subsoil varies from loose sand to heavy plastic silty clay loam.

Natural drainage conditions range from very poor to excessive. Water erosion is potentially severe on soils having sloping to steep topography, and accelerated erosion is severe where intertilled crops have been extensively grown without much thought given to erosion control.

A key to the soil series of Cass County is presented in table 5.

TABLE 5.—*Key to the soil series of Cass County, Ind.*¹

Soil characteristics	Brown Forest soils	V	IV	Gray-Brown Podzolic soils
Major profile (based on Indiana system of profile designation): ²	VI			
Drainage.....	Good to excessive.	Good to excessive.	Good.....	Nearly level.....
Relief.....	Nearly level to steep.	Rolling to level.....	Gently undulating to steep.	undulating.
Color of: ³ —				
Surface soil.....	Dark grayish brown or dark brown.	Grayish brown or yellowish brown.	Grayish brown, brown or yellowish brown.	Grayish brown or brownish gray.
Subsurface soil.....	Brown or grayish brown.	Yellowish brown, grayish brown, or brownish yellow.	Grayish brown or yellowish brown.	Pale yellow brown or light gray.
Upper subsoil.....	Brown or brownish gray.	Yellowish brown, brownish yellow, or reddish brown.	Yellowish brown, brownish yellow, or reddish brown.	Mottled gray, low, and brown.
Lower subsoil.....	Gray (limestone bedrock).	do.....	Brownish yellow or yellowish brown.	Gray and brown with blotching.
Soils of the uplands:				
Parent or underlying material—			Miami.....	
Wisconsin light to medium-textured highly calcareous glacial till.				
Gravely Wisconsin drift containing a high proportion of limestone.		Bellefontaine.....		
Very thin (6 to 16 inches) medium-textured highly calcareous Wisconsin till on limestone.	Farmington.....			
Light-colored overwash material over dark-colored depressional mineral soils of highly calcareous Wisconsin drift.				
Wisconsin sands and sandy till on medium- to light-textured, moderate to highly calcareous till.			Metea.....	
Wisconsin calcareous glacial drift composed largely of loose quartz sand.		Coloma.....		
Medium-textured highly calcareous Wisconsin glacial till, overlain by a mantle of silt (loess).			Russell.....	

See footnotes at end of table.

TABLE 5.—*Key to the soil series of Cass County, Ind.*!—Continued.

Soil characteristics	Brown Forest soils	V	IV	III
Soils of the glaciofluvial plains and terraces: Parent or underlying material— Thin (2 to 3 feet) medium-textured highly calcareous Wisconsin till or glaciofluvial deposits on limestone. Highly calcareous stratified gravel and sand, on glaciofluvial outwash plains and terraces of Wisconsin age. Poorly assorted highly calcareous gravel and sand, with some silt and clay; on prairie-border glacio- fluvial outwash plains. Strongly acid, deep, sandy glacio- fluvial outwash material, com- posed largely of quartz; reworked by wind action. Medium to strongly acid sandy glaciofluvial outwash material containing a high percentage of quartz; underlain at depths of 10 feet or more by heavier textured material. Calcareous glaciofluvial loose sands and gravel of Wisconsin age. Soils of the alluvial areas: Parent or underlying material— Neutral to slightly alkaline alluvium from highly calcareous Wisconsin glacial drift regions. Slightly acid to neutral alluvium from coarse-textured calcareous Wisconsin glacial drift regions. Organic soils: Parent material— Mixed woody and grassy or sodgy peat materials. Light-colored mineral overwash over peat materials.	VI	Fox 		

Soil characteristics	Humic Glay soils		Organic soils	IV
	VIII	IX		
Major profile (based on Indiana system of profile designation): *	Very poor.....	Very poor.....	Very poor.....	Good.....
Drainage.....	Level to shallow depressions.	Deeper depressions.	Shallow to deep depressions.	Nearly level.....
Relief.....				
Color of *—				
Surface soil.....	Dark brownish gray.	Very dark brownish gray.	Very dark gray to black.	Grayish brown.
Subsurface soil.....	do.....	do.....	do.....	Yellowish brown.
Upper subsoil.....	Mottled gray, yellow, and brown.	Gray or gray with faint yellow and brown mottles.	Very dark gray to black or yellow, olive, or brown.	do.....
Lower subsoil.....	do.....	Gray and yellow, mottled with brown.	do.....	do.....
Soils of the uplands:				
Parent or underlying material—				
Wisconsin light- to medium-textured highly calcareous glacial till.	Brookston.....	Kokomo.....		
Gravelly Wisconsin drift containing a high proportion of limestone.				
Very thin (6 to 15 inches) medium-textured highly calcareous Wisconsin till on limestone.				
Light-colored overwash material over dark-colored depressional mineral soils of highly calcareous Wisconsin drift.	Washtenaw ?	Washtenaw ?		
Wisconsin sands and sandy till on medium- to light-textured, moderate to highly calcareous till.				
Wisconsin calcareous glacial drift composed largely of loose quartz sand.				
Medium-textured highly calcareous Wisconsin glacial till, overlain by a mantle of silt (loess).	Brookston.....	Kokomo.....		

See footnotes at end of table.

TABLE 5.—Key to the soil series of Cass County, Ind.!—Cont.

Soil characteristics	Humle Glay soils			Organic soils	
	VIII Millsdale *	IX Millsdale		X	IV
Soils of the glaciofluvial plains and terraces: Parent or underlying material— Thin (2 to 3 feet) medium-textured highly calcareous Wisconsin till or glaciofluvial deposits on limestone. Highly calcareous stratified gravel and sand, on glaciofluvial outwash plains and terraces of Wisconsin age.	Westland	Abington			
Poorly assorted highly calcareous gravel and sand, with some silt and clay; on prairie-border glaciofluvial outwash plains.	Nyona	Lear			
Strongly acid, deep, sandy glaciofluvial outwash material, composed largely of quartz; reworked by wind action.	Newton	Dillon			
Medium to strongly acid sandy glaciofluvial outwash material containing a high percentage of quartz; underlain at depths of 10 feet or more by heavier textured material.					
Calcareous glaciofluvial loose sands and gravel of Wisconsin age. Highly calcareous rock rubble, sand and gravel of Wisconsin age.		Maumee			Genesee
Soils of the alluvial areas: Parent or underlying material— Neutral to slightly alkaline alluvium from highly calcareous Wisconsin glacial drift regions. Slightly acid to neutral alluvium from coarse textured calcareous Wisconsin glacial drift regions.					
Organic soils: Parent material— Mixed woody and grassy or sodgy peat materials. Light-colored mineral overwash over peat materials.				Carlisle Walktil	

¹ Soils that would key into many of the blank spaces have been mapped elsewhere in the State.

* Based on The Story of Indiana Soils, Purdue University Agricultural Experiment Station, Special Circular 1, by T. M. Bushnell, with some modifications.

* Colors are necessarily general and do not conform to the detail colors given in the individual soil descriptions; surface colors are for cultivated areas.

- 4 Conover soils in this county differ from those that are higher in organic matter.
- 5 Coloma, Plainfield, and Ottawa soils are intermediate.
- 6 Hartman soils are intermediate between Fox and Genesee soils.
- 7 Washtenaw soils are mapped in the same group as the Fox soils.
- 8 Millsdale soils are mapped in the same group as the Fox soils.

The great soil groups follow the classification of soils as given in the 1938 Yearbook of Agriculture ⁶ with modifications as given in Soil Science.⁷

The Roman numerals in table 5 are based on the Indiana system of major profile designation. Soil series listed in a horizontal line in the key are developed from similar parent material, differences in profile being largely dependent on natural drainage conditions during their development. Such a grouping of soil series is called a soil catena. The soils listed vertically under a given Roman numeral, or major profile number, have similar natural drainage conditions, but differences in profile characteristics are due to the kinds of parent material on which they are developed.

SOIL TYPES AND PHASES

In the following pages the soils, identified by the same symbols as those on the soil map, are described in detail and their agricultural relations are discussed. Their location and distribution are shown on the soil map, and their acreage and proportionate extent are given in table 6.

Abington loam (0 to 2 percent slopes) (AA).—This soil was developed on highly calcareous stratified gravel and sand of Wisconsin glacial drift. It is the very poorly drained very dark-colored member of the soil catena that also includes the well to somewhat excessively drained Fox, moderately well drained Bronson, imperfectly drained Homer, and the very poorly drained dark-colored Westland soils.

Abington loam occurs in the deeper depressions and depressed flats in glaciofluvial plains and terraces, especially in old glacial drainageways. It usually occurs in long, relatively narrow areas in close association with the above-mentioned soils. Practically all the areas were ponded for a part of each year under natural drainage conditions. The greater part of the areas are now artificially drained to permit cultivation. This is easily accomplished, where outlets are available, because of the loose porous substrata. The native vegetation was marsh grasses and sedges and deciduous swamp forest associations, including elm, soft maple, and ash.

Profile description in cultivated areas:

- 0 to 7 inches, very dark brownish-gray to very dark-gray friable medium granular loam; organic content high and apparently rather stable under cultivation; some rounded pebbles on the surface and throughout the horizon; neutral to very slightly acid.
- 7 to 18 inches, very dark-gray heavy loam to clay loam relatively high in organic matter; material breaks into moderately well developed blocky aggregates; neutral.
- 18 to 30 inches, medium to light-gray sticky clay loam with considerable gravel and small rounded stones; streaks and lenses of the darker colored material from the above horizon extend into this horizon; few pale-yellow streaks and blotches present, especially in the lower part; breaks into large angular chunks or pieces that are sticky when wet, firm to plastic when moist, and hard when dry; neutral.
- 30 to 50 inches, mottled gray, yellow, and brown gravelly clay loam that breaks into large angular pieces; plastic when moist, sticky when wet, and hard when dry; a considerable quantity of small rounded stones and an occasional large boulder; neutral.
- 50 inches +, gray and yellow highly calcareous stratified loose gravel with some sand; contains a high percentage of limestone material.

⁶ UNITED STATES DEPARTMENT OF AGRICULTURE. SOILS AND MEN. U. S. Dept. Agr. Yearbook 1938, 1,232 pp. illus. 1938.

⁷ THORP, J., and SMITH, G. D. HIGHER CATEGORIES OF SOIL CLASSIFICATION: ORDER, SUBORDER, AND GREAT SOIL GROUPS. Soil Science 67 (2): 117-126. 1949.

TABLE 6.—*Acreage and proportionate extent of the soils mapped in Cass County, Ind.*

Soil	Acres	Per- cent	Soil	Acres	Per- cent
Abington loam.....	1, 033	0. 4	Genesee loam.....	834	0. 3
Abington silty clay loam.....	1, 318	. 5	Genesee silt loam.....	1, 804	. 7
Aubbeenaubbee fine sandy loam.....	506	. 2	Gravel pits.....	482	. 2
Bellefontaine fine sandy loam.....	3, 662	1. 4	Griffin fine sandy loam.....	732	. 3
Bellefontaine loam.....	2, 370	. 9	Hartman loam.....	506	. 2
Berrien fine sandy loam.....	1, 047	. 4	Hartman silt loam.....	228	. 1
Berrien loamy fine sand.....	561	. 2	Homer fine sandy loam.....	1, 052	. 4
Bethel silt loam.....	10	(¹)	Homer silt loam.....	1, 180	. 4
Bronson fine sandy loam.....	322	. 1	Kokomo loam.....	3, 378	1. 3
Brookston loam.....	22, 702	8. 5	Kokomo silty clay loam.....	2, 681	1. 0
Brookston silty clay loam.....	43, 502	16. 3	Lear loam.....	1, 561	. 6
Carlisle muck.....	4, 201	1. 6	Limestone rockland.....	413	. 2
Carlisle silty muck.....	1, 010	. 4	Made land.....	273	. 1
Coloma fine sand.....	408	. 2	Maumee fine sandy loam.....	1, 289	. 5
Coloma loamy fine sand.....	6, 090	2. 3	Maumee loam.....	613	. 2
Conover fine sandy loam.....	425	. 2	Metea fine sandy loam.....	5, 080	1. 9
Conover loam.....	4, 291	1. 6	Miami fine sandy loam.....	25, 984	9. 8
Crosby fine sandy loam.....	7, 181	2. 7	Miami loam.....	4, 804	1. 8
Crosby loam.....	1, 044	. 4	Miami silt loam.....	6, 975	2. 6
Crosby silt loam.....	1, 407	. 5	Sloping phase.....	1, 681	. 6
Delmar-Bethel silt loams.....	60	(¹)	Steep phase.....	545	. 2
Delmar silt loam.....	92	(¹)	Millsdale silty clay loam.....	3, 001	1. 1
Dillon fine sandy loam.....	1, 212	. 5	Milton silt loam.....	2, 353	. 9
Eel loam.....	1, 550	. 6	Newton fine sandy loam.....	1, 830	. 7
Eel silt loam.....	4, 904	1. 8	Newton loam.....	20	(¹)
Farmington silt loam.....	1, 550	. 6	Nyona loam.....	3, 170	1. 2
Fincastle-Crosby silt loams.....	19, 163	7. 2	Ottawa loamy fine sand.....	836	. 3
Fincastle silt loam.....	7, 623	2. 9	Plainfield fine sand.....	2, 610	1. 0
Fox fine sandy loam.....	2, 973	1. 1	Rolling phase.....	2, 364	. 9
Deep phase.....	1, 191	. 4	Riverwash.....	63	(¹)
Fox loam.....	2, 305	. 9	Russell-Miami silt loams.....	5, 985	2. 3
Steep phase.....	1, 533	. 6	Sloping phases.....	128	(¹)
Fox silt loam.....	4, 395	1. 7	Russell silt loam.....	15, 430	5. 8
Deep phase.....	5, 271	2. 0	Sloping phase.....	1, 493	. 6
Genesee fine sandy loam.....	902	. 3	Steep phase.....	1, 404	. 5
			Wallkill silt loam.....	621	. 2
			Washtenaw silt loam.....	792	. 3
			Westland silty clay loam.....	3, 591	1. 4
			Total.....	265, 600	100. 0

¹ Less than 0.1 percent.

Variations in the profile characteristics of Abington loam, as mapped, are in the organic content of the surface and upper subsoil horizons; in the color, texture, and thickness of the various horizons; and in the depth to calcareous gravel. A few of the uncultivated areas have a thin surface layer of mucky material. A few areas, located north of Kenneth and near Georgetown, have lighter colored surface and upper subsoil horizons that are somewhat lower in organic-matter

content and are thinner than normal. These areas would have been separated on the map as Westland loam if they had been of sufficient extent.

Use and management.—It is estimated that 60 percent of Abington loam is under cultivation, and the rest is in permanent pasture or forest.

The crop rotation consists of corn, wheat or oats, soybeans, and hay crops that include alfalfa, clover and timothy, or alfalfa grown alone. Where this soil comprises a large part of a field unit, corn is grown for 2 or more consecutive years. In seasons of abnormally high-moisture conditions, yields are materially reduced, and the crop is often drowned out where drainage is inadequate.

Small grains, including wheat and oats, are not so well adapted to this soil as to the lighter colored, better drained soils. Wheat is occasionally winterkilled by heaving and by excess moisture, and both oats and wheat lodge because of the high nitrogen content of the surface soil. It is necessary for small grains to be grown often in the rotation because the soil occurs in small areas in close association with larger areas of Fox, Bronson, and other soils.

This soil is well adapted to the growing of soybeans. They are grown both for hay and seed, but the recent increase in acreage has been largely for seed.

Hay crops include a mixture of clover, alfalfa, timothy, and occasionally bromegrass or alfalfa or clover grown alone. Excellent stands and yields are obtained without the use of lime. There is, however, some damage to hay crops from winterkilling and drowning out.

Abington loam is well suited to such special crops as sweet corn and tomatoes; rather heavy applications of fertilizer are required. It supports good stands of bluegrass pasture, but for best production many of the pastures require fertilization as well as control of weeds by mowing.

Specific management practices for Abington loam are given in management group 8 of table 10.

Abington silty clay loam (0 to 2 percent slopes) (Ab).—This soil was developed on highly calcareous stratified gravel and sand of Wisconsin glacial drift. It is a very poorly drained very dark soil and is a member of the catena that also includes the well to somewhat excessively drained Fox, moderately well drained Bronson, imperfectly drained Homer, and the very poorly drained dark-colored Westland soils.

This soil occupies positions similar to those occupied by Abington loam. Under natural drainage conditions, practically all the areas were ponded for a part of each year, but at present most of the areas are drained artificially to permit cultivation. Both open ditches and tile are used, and where outlets are available drainage is easily accomplished by lowering the water table in the loose gravel substrata. The native vegetation included marsh grasses and sedges and deciduous swamp forest associations.

Profile description in cultivated areas:

- 0 to 7 inches, very dark brownish-gray to very dark-gray silty clay loam, high in organic matter; coarse granular structure; some rounded pebbles on the surface and throughout the horizon; neutral.
- 7 to 18 inches, very dark-gray silty clay loam, relatively high in organic matter; material breaks into blocky aggregates; small rounded pebbles and an occasional large boulder present; neutral.

- 18 to 30 inches, medium to light-gray plastic clay loam to silty clay, with considerable gravel and small rounded stones; streaks or lenses of the dark-colored material from above extend into this horizon; a few pale-yellow streaks and blotches present, especially in the lower part; breaks into large angular pieces that are sticky when wet, plastic when moist, and hard when dry; neutral.
- 30 to 50 inches, mottled gray, yellow, and brown gravelly clay loam to silty clay that breaks into large angular pieces, plastic when moist, sticky when wet, and hard when dry; neutral.
- 50 inches +, gray and yellow loose highly calcareous stratified gravel and some sand.

Variations in profile characteristics are in the content of organic matter in the surface and upper subsoil horizons; in the color, texture, and thickness of the horizons; and in the depth to calcareous gravel. Where areas grade into Westland soils the color of the surface soil is lighter, the organic content lower, and the thickness of the organic-bearing layers less than normal. A few wooded areas have a thin surface layer of black mucky material.

Use and management.—The crop rotation is similar to that on the associated soils, except where the greater part of a field unit is composed of this soil. The common rotation includes corn, wheat or oats, soybeans, and hay crops. This is varied to include an occasional special crop, such as tomatoes and sweet corn.

Corn is grown for 2 or more consecutive years in fields largely of Abington silty clay loam. It usually follows hay crops. Some areas are drowned out in seasons of abnormally high moisture.

Wheat usually follows corn or soybeans and as a general practice is fertilized with commercial fertilizer. It is occasionally injured by heaving or prolonged wet periods. Yields average 15 bushels an acre.

Oats usually replace wheat in the rotation. Both wheat and oats, as well as other small grains, are occasionally damaged by lodging of the grain because of the high nitrogen content of the soil.

Soybeans are well adapted. They usually follow corn or small grains in the rotation.

Hay crops include a mixture of clover, alfalfa, and timothy or alfalfa, or clover grown alone. It is not necessary to apply lime to secure stands of clover and alfalfa. There is some damage to hay crops from heaving and drowning out.

Permanent bluegrass pasture is of fair to good quality. The live-stock-carrying capacity on many of the pastures, however, could be greatly increased by a good pasture-improvement plan that included mowing to decrease weeds and the use of fertilizer high in phosphorus.

Specific rotations and other suggested management practices for this soil are given under management group 8 in table 10.

Aubbeenaubbee fine sandy loam (0 to 2 percent slopes) (Ac).—This is a light-colored soil developed on sandy outwash or till material over medium- to light-textured glacial till. It is the imperfectly drained member of the soil catena that also includes the well-drained Metea soils.

This soil is mapped principally in the northwestern part of the county, in association with Crosby and Metea fine sandy loams. The boundaries between it and the above-mentioned soils are in some instances arbitrarily drawn, as there is a gradual transition in drainage conditions to Metea fine sandy loam, and in depth of sandy material to Crosby fine sandy loam. Most of the areas are artificially drained

to permit cultivation. Surface runoff is slow. The soil may become excessively dry in summer months because of the looseness of the upper part of the profile. Native vegetation included a beech-maple forest association.

Profile description in cultivated areas:

- 0 to 7 inches, brownish-gray to light brownish-gray fine sandy loam, low in organic content; medium to strongly acid.
- 7 to 11 inches, brownish-gray to yellowish-gray fine sandy loam; medium to strongly acid.
- 11 to 24 inches, mottled gray, yellow, and brown fine sandy loam to fine sand; medium to strongly acid.
- 24 to 38 inches, mottled gray, yellow, and brown light clay loam or sandy clay loam, containing small stones and an occasional boulder; material breaks into coarse subangular blocky aggregates that break down easily when moist; slightly hard when dry; medium acid.
- 38 inches +, gray, mottled with yellow and brown, clay loam highly calcareous glacial till.

Variations in profile characteristics are in the color, texture, and thickness of the various horizons and the depth to calcareous till. The combined thickness of the first three layers, the sandy material, varies from 20 to 30 inches; and the depth to calcareous till varies from 32 to 44 inches.

Use and management.—The crop rotation on Aubbeenaubbee fine sandy loam is necessarily similar to that on the associated Crosby and Metea fine sandy loams and the other associated soils. This includes corn, soybeans, wheat or oats, and hay crops. The rotation is varied to include special field and truck crops or special pasture crops where hay crops have failed. It is essential that large quantities of organic matter be applied to this soil, either as barnyard manure or green manure; that sufficient lime be used; and that the rotation include a high proportion of hay crops to maintain or increase productivity. The soil responds well to fertilizers, but plant nutrients are leached rather quickly because of the sandiness of the surface and upper subsoil.

Corn usually follows hay crops. Yields are materially reduced in seasons of low moisture.

Oats follow corn or soybeans and usually take the place of wheat in the rotation. This soil is not so well adapted to soybeans as are the heavier textured light- and dark-colored associated soils. Yields are reduced in seasons of low moisture.

Hay crops include a mixture of clover, alfalfa, and timothy or alfalfa or clover grown alone. Special hay crops, as Sudangrass and millet, are grown occasionally when the regular hay crops fail or when there is a need for additional hay or grass. It is necessary to apply sufficient lime to this soil for legumes.

Permanent bluegrass pastures of fair quality occupy a small proportion of the total acreage of this soil. Most of them can be improved by the use of sufficient lime and fertilizer and by mowing to decrease weeds.

Suitable rotations and other management practices on this soil are given under management subgroup 5B in table 10.

Bellefontaine fine sandy loam (2 to 10 percent slopes) (BA).—This light-colored soil occurs in the regions of light-textured Wisconsin glacial drift. It is characterized by a substratum of calcareous gravel and sand at depths of 3 to 4 feet.

The relief ranges from undulating to sloping. The greater part of the area is on slopes of 2 to 8 percent. Both the external and internal drainage are somewhat excessive. This soil was mapped more extensively southwest and northwest of Royal Center, west of Georgetown, and northwest of Logansport. The native vegetation consisted chiefly of oak and hickory.

Profile characteristics in cultivated areas:

- 0 to 7 inches, grayish-brown to yellowish-brown fine sandy loam relatively low in organic-matter content; slightly to medium acid.
- 7 to 13 inches, light yellowish-brown sandy loam to light loam; friable to loose; slightly to medium acid.
- 13 to 30 inches, yellowish-brown to weak reddish-brown waxy and gravelly clay loam; material breaks into irregular-sized angular pieces that are hard when dry; medium acid.
- 30 to 36 inches, dark yellowish-brown to brownish-yellow waxy and gravelly clay loam that breaks into angular pieces; an abrupt change from the horizon above to this material, and tongues or lenses of this horizon extend downward into the underlying material; slightly acid to neutral.
- 36 inches +, gray and yellow loose stratified calcareous gravel and sand in which cross bedding is prominent.

Variations in the profile characteristics of Bellefontaine fine sandy loam are in the thickness and texture of the various horizons and in the depth to the gravel and sand, which varies from 30 to 48 inches.

Use and management.—Bellefontaine fine sandy loam is not so well adapted to general farm crops common to the area as are the heavier textured upland soils. The rotation in use on the smoother areas of this soil is similar to that in use on areas of the associated Miami and Metea fine sandy loams. It includes corn, wheat, soybeans, mixed hay, and alfalfa.

Wheat is better adapted to this soil than oats, and a large proportion of the small grain grown consists of wheat. The acreage of soybeans grown on this soil has increased in recent years, the increase being largely for seed. Alfalfa is probably better adapted than other hay crops, and good stands are obtained after sufficient lime and commercial fertilizer have been applied to the soil. Clover is not so well adapted, as it is not able to withstand the droughtiness of the soil, especially during the hot, dry summer months.

Suitable rotations are given under management subgroup 2C in table 10.

Bellefontaine loam (2 to 10 percent slopes) (Bb).—This is a light-colored soil characterized by a substratum of calcareous gravel and sand at depths of 3 to 4 feet. This soil occurs in the regions of light-textured Wisconsin drift; the larger areas are northeast of Logansport and in the northwestern part of the county. It occurs as kames and low morainic hills that are usually somewhat higher in elevation than the surrounding areas. Surface drainage is good to excessive, and internal drainage is somewhat excessive, owing to the porosity of the substratum. The native vegetation consisted chiefly of oak and hickory and a small number of walnut, maple, elm, and other associated species.

Profile characteristics in cultivated areas:

- 0 to 7 inches, grayish-brown to yellowish-brown friable loam, relatively low in organic-matter content; numerous small pebbles on the surface and throughout the horizon and an occasional boulder on the surface; slight to medium acid.
- 7 to 12 inches, yellowish-brown friable heavy loam to silt loam with coarse crumb structure; medium acid.

12 to 30 inches, yellowish-brown to weak reddish-brown gravelly clay loam; breaks into irregular-sized angular pieces that are plastic when moist and hard when dry; medium acid.

30 to 36 inches, dark yellowish-brown to brownish-yellow gravelly clay loam that breaks into angular pieces; an abrupt change from the horizon above to this material, and tongues or lenses of this horizon extend downward into the underlying material; slightly acid to neutral.

36 inches +, gray and yellow loose stratified calcareous gravel and sand; cross bedding is usually prominent.

Variations in the profile characteristics of Bellefontaine loam are in the depth to the substratum of gravel and sand. It varies from 26 to 48 inches or more. In areas where Bellefontaine loam is intimately associated with Miami or Metea soils, small areas of these soils are included with Bellefontaine loam on the map.

A large proportion of this soil, especially the steeper sloping areas, is at present in forest or in permanent bluegrass pasture. The soil is not well adapted to oats and red clover. A small proportion is cultivated to corn, wheat, clover, and alfalfa, but crop yields are medium to low. Good stands of alfalfa are obtained on this soil after sufficient quantities of lime and commercial fertilizers are applied. It is probably better adapted to this crop than to others common to the region.

Suitable rotations for this soil are given under management subgroup 2C in table 10.

Berrien fine sandy loam (0 to 3 percent slopes) (Bc).—This is a light-colored soil developed on loose acid sands. It is the moderately well drained member of the soil catena that also includes the excessively drained Plainfield, imperfectly drained Morocco, very poorly drained dark-colored Newton, and very poorly drained very dark-colored Dillon soils. Morocco soils are not extensive enough in this county to be mapped separately. Berrien fine sandy loam occurs on nearly level to undulating relief, often in low, stationary, dunelike areas that rise a few feet above the level of the associated dark-colored soils. There is little surface runoff, as the loose coarse material of the profile allows the rainfall to move downward rather rapidly. This soil is mapped principally in the northwestern part of the county and is associated with the above-mentioned soils.

Profile characteristics are similar to those of Berrien loamy fine sand, except that the surface 8 to 10 inches is fine sandy loam. The profile is medium to strongly acid to depths of 4 feet or more except in a few included areas in northern Jefferson Township. Here the surface and subsoil horizons are slightly acid.

Use and management.—A large proportion of Berrien fine sandy loam is at present in forest or in low-grade pasture. The pasture includes predominantly broomesedge and various weeds, and a small proportion of bluegrass. The cultivated areas are cropped to corn, soybeans, wheat, and hay crops, and an occasional special crop such as berries and melons. Organic matter and plant nutrients are very low and the soil is droughty, especially in summer and early fall. It is not well adapted to field crops but is better adapted to melons, cucumbers, berries, and similar crops.

Suitable rotations for this soil are given under management group 4 in table 10.

Berrien loamy fine sand (0 to 3 percent slopes) (B_D).—This is a light-colored moderately well drained soil developed on loose acid sands. It occurs on nearly level to gently undulating relief, occasionally as low, stationary dunes a few feet above the associated dark-colored soils. There is very little surface runoff, and water moves through the profile very rapidly. It is mapped principally in the western and northwestern parts of the county in association with Plainfield, Dillon, and Newton soils, and like Berrien fine sandy loam is a member of the catena that includes these soils. Native vegetation included predominantly oaks.

Profile description in cultivated areas:

- 0 to 7 inches, grayish-brown to light yellowish-brown incoherent or loose loamy fine sand, very low in organic-matter content; medium to strongly acid.
- 7 to 22 inches, light brownish-yellow to pale-yellow loose loamy fine sand or fine sand; strongly acid.
- 22 inches +, mottled gray and yellow loose sand that extends to depths of 4 to 20 feet or more; yellow color occasionally occurs as large blotches or pockets; an occasional thin seam of yellow slightly coherent sandy material.

Use and management.—A large proportion of Berrien loamy fine sand is in forest. Areas under cultivation are cropped to corn, wheat, soybeans, and hay crops and some special crops such as berries and melons. The soil is very low in organic-matter content and plant nutrients. It is essential that all available organic matter be turned under and that heavy rates of fertilizer be used. This soil is droughty, especially during the summer and early fall, because of the loose and porous surface and subsoil material. Plant nutrients leach rather rapidly. Yields of corn and soybeans are low largely because of the lack of moisture during the growing season. The soil is probably better suited to such crops as melons, cucumbers, and berries than to field crops. Permanent pastures include principally broomsedge and various weeds and only a small proportion of bluegrass. Bluegrass is hard to maintain because of the low moisture-supplying capacity of the soil, and livestock tend to destroy it when the areas are pastured.

Suitable rotations and other management practices are given under management group 4 in table 10.

Bethel silt loam (0 to 2 percent slopes) (B_E).—This is light-colored soil developed on medium-textured highly calcareous Wisconsin glacial till. It is the poorly drained member of the soil catena that also includes the well-drained Miami, imperfectly drained Crosby, very poorly drained dark-colored Brookston, and the very poorly drained very dark-colored Kokomo soils.

This soil occurs in small isolated areas associated with Crosby silt loam and Brookston silty clay loam. The relief is nearly level, and both internal and external drainage are very slow. A majority of the areas are at present artificially drained to permit cultivation, but some are in need of more adequate drainage. Native vegetation included a deciduous forest in which beech was prominent.

Profile description in cultivated areas:

- 0 to 7 inches, light-gray to gray friable granular silt loam; organic content low; small, brown or pale-yellow, hard iron concretions numerous on the surface and throughout the horizon; surface 2 to 3 inches dark gray in wooded areas; medium acid.

- 7 to 10 inches, light-gray to gray friable coarse granular heavy silt loam to light silty clay loam with a few light-yellow blotches or spots and numerous iron concretions; medium acid.
- 10 to 16 inches, gray, mottled and blotched with brown and pale yellow, gritty silty clay loam; numerous small brown iron concretions present as well as variable quantities of grit, pebbles, and small rock fragments; medium to strongly acid.
- 16 to 36 inches, mottled gray, yellow, and brown heavy, plastic silty clay loam that breaks into blocky aggregates $\frac{1}{2}$ to $1\frac{1}{2}$ inches in diameter; a tendency toward ill-defined columnar structure with a vertical axis 2 or 3 times the length of the horizontal axis; rather impervious to moisture movement and somewhat impervious to plant roots; medium to strongly acid.
- 36 inches +, mottled gray, yellow, and brown loam calcareous glacial till composed of unsorted silt, clay, sand, and rock fragments.

Variations in the profile characteristics of Bethel silt loam are in the texture and thickness of the various horizons and in the depth of calcareous till. The areas of this soil surrounded by or in close association with areas of Brookston silty clay loam have a somewhat darker colored surface soil than normal.

Use and management.—Owing to the relatively low fertility and poor surface and internal drainage conditions, much of Bethel silt loam has remained in timber. Cleared areas are either under cultivation or are in bluegrass pasture, although some are idle in seasons of abnormally high moisture. Corn, wheat, and clover are the principal crops grown. Adequate artificial drainage is necessary on this soil to obtain good yields, although in some instances it is difficult because of the nearly level relief and the distance to outlets. The soil is deficient in organic matter as well as in most of the necessary plant nutrients.

Any rotation system or management practice should include the plowing under of all organic matter available, and the liberal use of commercial fertilizer. This soil is not well adapted to oats, as planting is often delayed in spring and the crop suffers from lack of moisture in summer because of the rapid drying out of the soil. It is necessary to lime the soil to obtain good stands of alfalfa and clover. These crops, however, are frequently severely damaged by winterkilling. Timothy is probably better suited than either clover or alfalfa.

Suitable rotations and other management practices are given under management group 6 in table 10.

Bronson fine sandy loam (0 to 2 percent slopes) (Br).—This light-colored soil was developed on highly calcareous glaciofluvial gravel and sand of Wisconsin Age. It is the moderately well drained member of the soil catena that also includes the well to somewhat excessively drained Fox, imperfectly drained Homer, very poorly drained dark-colored Westland, and very poorly drained very dark-colored Abington soils. It occurs on nearly level relief in areas of various size and shape, principally in the northwestern part of the county in close association with the above-mentioned soils and with Nyona soils. Natural drainage conditions in the upper part of the profile are good but are somewhat restricted in the lower part. Artificial drainage is not necessary except in a few areas. Drainage is easily accomplished, where outlets are available, by lowering the general water table in the area. The movement of moisture through the soil is moderate to rapid. Erosion is not a problem except for slight wind

erosion on some areas. Native vegetation included oak and hickory and some maple and associated species.

Profile description in cultivated areas:

- 0 to 7 inches, grayish-brown friable fine sandy loam, relatively low in organic-matter content; variable content of small rounded rock fragments and pebbles on the surface and in the horizon but never sufficient to interfere with cultivation; slightly to medium acid.
- 7 to 18 inches, pale-yellow to light brownish-yellow fine sandy loam to loam; material is friable in place and breaks into small subangular blocky aggregates; medium acid.
- 18 to 36 inches, mottled gray, yellow, and brown gravelly clay loam to sandy clay loam that breaks into irregularly sized and shaped pieces; slightly plastic when moist, slightly sticky when wet, and hard when dry; a considerable number of small rounded stones and an occasional boulder; medium to strongly acid in the upper part of the horizon and slightly acid in the lower part.
- 36 inches +, gray and light-yellow highly calcareous stratified gravel with some sand.

Variations are chiefly in the color, texture, and thickness of the horizons; depth to mottling; and depth to calcareous gravel. The depth to mottling varies from 15 to 26 inches, and the depth to calcareous gravel from 28 to 40 or more inches. The depth to mottling is greater than normal where Bronson fine sandy loam grades into Fox fine sandy loam, and less than normal where it grades into Homer soils. A few areas included in the northwestern part of the county have subsoil horizons that contain more sandy material and are lighter textured than normal.

Use and management.—Bronson fine sandy loam is closely associated with Fox, Homer, Nyona, and other soils, and management practices and crops grown are affected by this association. The principal rotation includes corn, wheat, alfalfa, and soybeans and a somewhat smaller proportion of mixed hay, oats, vegetable crops, and minor field and hay crops. The content of organic matter and nitrogen in the surface soil is relatively low, and the turning under of all available organic matter and the use of commercial fertilizers are essential in order to maintain an increased productivity.

Corn usually follows hay crops in the rotation, or it may be grown where small grains have failed. Soybeans usually follow corn or small grains. Oats are not so well adapted as wheat, and a much smaller acreage of this crop is grown than wheat. Some farmers use rather heavy applications of commercial fertilizer with small grains so that there will be enough plant nutrients for hay crops, which are sown with small grains in spring.

Alfalfa is the principal hay crop, although a mixture of alfalfa, clover, timothy, alsike, and in some instances brome grass, is in rather wide use. Alfalfa is better adapted than the other hay crops because of its ability to withstand the somewhat droughty conditions prevailing late in spring and early in fall. A few areas are in permanent bluegrass pasture of fair quality. Permanent pastures can be improved materially by the use of sufficient lime and phosphate fertilizer and by weed control. Only a small total acreage is in forest.

Suitable rotations and other management practices are given under management subgroup 2B in table 10.

Brookston loam (0 to 2 percent slopes) (Bg).—This soil was developed on highly calcareous Wisconsin glacial till. It is the very poorly drained dark-colored member of the soil catena that also includes the

well-drained Miami, imperfectly drained Crosby, poorly drained Bethel, and very poorly drained very dark-colored Kokomo soils.

Brookston loam is mapped in every township north of the Wabash River and is rather extensive in the north-central part of the county. It occurs in slight depressional areas and in some cases in rather extensive flats. It is closely associated with Crosby and Conover loams and fine sandy loams and in some instances with Kokomo loam. Both internal and external natural drainage are very poor, but the greater part of the areas have been artificially drained to permit cropping. Some of the more extensive areas, however, are in need of more adequate drainage. The natural vegetation consisted of water-tolerant trees—chiefly red maple, elm, and ash—and marsh grasses.

Profile characteristics in cultivated areas:

- 0 to 7 inches, dark-gray to very dark brownish-gray loam, relatively high in organic matter; neutral to slightly acid.
- 7 to 15 inches, dark-gray sandy clay loam to clay loam with some faint light-yellow or rust-brown mottling in the lower part of the horizon; organic content relatively high; breaks into irregular-sized angular pieces easily broken down when moist but hard when dry; permeable to moisture and to plant roots; neutral.
- 15 to 50 inches, mottled gray, yellow, and brown plastic and gritty clay loam to sandy clay loam that contains an occasional boulder and rock fragments of various size and shape; breaks into large angular pieces that are hard when dry; neutral.
- 50 inches +, mottled gray, yellow, and brown light loam calcareous glacial till composed of unassorted silt, clay, sand, and rock fragments.

Variations in the profile characteristics of Brookston loam are in the texture and thickness of the different horizons and the depth to calcareous till. The shallower depressions and that part of the larger areas bordering the associated light-colored soils have sandy loam to light loam surface textures. Some areas have a few inches of local wash from the surrounding areas on the surface.

Use and management.—The use and management practices, including the rotation system, on this soil are very similar to those on the associated light-colored soils, except where Brookston loam forms a large part of a field unit. Owing to the irregular shape of many of the areas and the close association with the light-colored soils, it is usually impractical to handle this soil in a different way from the associated soil. The rotation in common use includes corn, wheat or oats, and hay crops; or corn, soybeans, wheat or oats, and hay crops. Where a field unit is composed largely of Brookston loam, corn may be grown for 2 or more consecutive years.

Hay crops include a mixture of clover, alfalfa, timothy, alsike, and in some instances brome grass, or clover or alfalfa grown alone. Good stands of clover and alfalfa, as well as the other above-mentioned hay crops, can be obtained without the use of lime. It is necessary, however, that adequate artificial drainage be installed. Clover grown alone has been replaced by mixed hay or by alfalfa in recent years. Some damage occurs to hay crops from drowning out and from heaving.

Brookston loam is well adapted to vegetables, especially tomatoes and sweet corn.

A small part of this soil is in permanent bluegrass pasture, and small isolated areas are in forest.

Suitable rotations and other management practices are given under management group 7 in table 10.

Brookston silty clay loam (0 to 2 percent slopes) (B_h).—This soil occurs on broad upland flats or slight depressions in the areas of Wisconsin glacial till. It is the very poorly drained dark-colored member of the soil catena that also includes the well-drained Miami; imperfectly drained Crosby; poorly drained Bethel; and very poorly drained, very dark-colored Kokomo soils. It is also the very poorly drained member of the catena that includes the well-drained Russell; imperfectly drained Fincastle; poorly drained Delmar; and very poorly drained, very dark-colored Kokomo soils.

Brookston silty clay loam is most extensively mapped in the upland areas south of the Wabash River. Here it occurs as rather extensive flats or slightly depressed areas, closely associated with Fincastle and Crosby soils. It also occurs less extensively in the upland areas between the Wabash and the Eel Rivers, and north of these rivers in the areas of glacial till that are derived from medium-textured drift. Both external and internal drainage are naturally poor, but most areas have been artificially drained to permit cropping. The native vegetation consisted of water-tolerant trees—chiefly red maple, elm, and ash—and marsh grasses.

Profile characteristics in cultivated areas:

- 0 to 7 inches, very dark-gray to very dark brownish-gray silty clay loam, relatively high in organic-matter content; neutral to slightly acid.
- 7 to 14 inches, dark-gray silty clay loam to clay loam with some faint light-yellow or brown mottlings in the lower part of the horizon; organic-matter content is relatively high; breaks out into medium to coarse blocky aggregates that can be easily broken down when moist but are hard when dry; roots have no difficulty in penetrating this horizon; neutral.
- 14 to 48 inches, mottled gray, yellow, and brown plastic gritty clay loam to clay, containing an occasional boulder and various-sized rock fragments; breaks into large angular pieces that are hard when dry; neutral.
- 48 inches +, mottled gray, yellow, and brown clay loam to loam calcareous glacial till composed of unassorted silt, clay, sand and rock fragments; this represents the parent soil material.

Variations in profile characteristics occur in the texture and thickness of the various horizons and in the depth to calcareous till. Surface textures in the shallower depressions and in that part of the larger areas bordering the associated light-colored soils are silt loam to heavy silt loam. On the surface of some areas there are a few inches of local wash from surrounding soils. Areas of Brookston silty clay loam associated with Fincastle and Russell soils have slightly acid surface soils that are somewhat lighter textured and contain less organic matter than the areas associated with Miami and Crosby soils. The depth to calcareous till is usually greater in areas associated with the Russell soils.

Use and management.—It is estimated that over 95 percent of Brookston silty clay loam is cleared of forest and is either under cultivation or is permanent bluegrass pasture.

Management practices and rotations are essentially the same as those on the light-colored soils but yields of crops are generally higher. The rotation in common use is one that includes corn, wheat or oats, and hay.

Another common rotation includes corn, soybeans, wheat or oats, and 1 or more years of alfalfa. The fertilizer or plant-nutrient requirements for most crops grown on this soil are somewhat different from the requirements on the light-colored associated soils. It is,

however, very difficult to treat areas of Brookston silty clay loam differently unless they make up a large portion of a field unit.

Corn usually follows hay crops or vegetables in the rotation system. Where this soil comprises a large portion of a field unit, corn is often grown for 2 or more consecutive years. Yields of 70 or more bushels an acre are common under good management practices and favorable weather conditions.

Yields of oats depend largely on weather conditions during the growing season. Some loss results from lodging because of the high nitrogen and organic-matter content of the soil. Use of newer stiff-strawed varieties may reduce this loss.

Brookston silty clay loam is very well adapted to soybeans. They are grown both for grain and hay, but the recent increase in soybean acreage has been largely for grain. Experiments have shown that indirect fertilization of soybeans increases yields. This is accomplished by applying large quantities of fertilizer with small grains, corn, or other crops that precede soybeans in the rotation.

Excellent stands of alfalfa and clover can be obtained without the use of lime, and yields are usually high. There is, however, some damage to alfalfa and clover from winterkilling. Many farmers grow a mixture of alfalfa, clover, and timothy rather than alfalfa or clover alone.

This soil is well suited to such special crops as sweet corn and tomatoes. These crops are usually fertilized rather heavily, especially tomatoes, and yields average $3\frac{1}{2}$ to 5 tons of sweet corn and 8 to 12 tons of tomatoes an acre.

Suitable management practices are given under management group 7 of table 10.

Carlisle muck (0 to 2 percent slopes) (CA).—This is a very poorly drained organic soil developed on mixed woody and grass or sedge peat materials. It occupies depressional areas and low, broad flats, principally in the northern part of the county. A considerable part has been artificially drained to permit cultivation, but many areas are too wet for crop production at present.

Profile description in cultivated areas:

0 to 7 inches, very dark brownish-gray to black fine granular muck; slightly acid.

7 to 20 inches, very dark-gray to black coarse granular and somewhat fibrous muck; slightly acid.

20 inches +, yellow and brown fibrous or macerated peaty and mucky material containing numerous partially decomposed remains of reeds, leaves, sedges, trees, and other plant life.

Variations are in the color and thickness of the different horizons. The thickness of the last horizon is quite variable—3 to more than 20 feet—and is underlain by sand, clay, or glacial till. Included are a few small areas in Jefferson Township that are underlain by gray calcareous marl at depths of 15 to 30 inches. These areas would have been separated on the map as Edwards muck if they had been of sufficient extent.

Use and management.—The drained areas are well adapted to field corn, sweet corn, potatoes, and other vegetables but are not well adapted to small grains. The principal crops are corn and vegetables, although a rotation of corn, soybeans, wheat or oats, and hay crops is practiced on some areas. The organic-matter and nitrogen content is high; but the supply of phosphate and potash is relatively low, and

fertilizers high in these two elements should be used on this soil. Small grains and hay crops are occasionally drowned out. Small grains lodge because of the high content of organic matter and nitrogen, although the newer oat varieties with stiffer straw may be successful. Excellent stands of bluegrass are obtained on both the drained and undrained areas. A few of the more poorly drained areas are in forest.

The rotation on the included Edwards muck consists of corn, wheat, and hay; yields are about equal to those obtained on Carlisle muck except in those areas where the marl occurs at shallower depths. Here yields are somewhat lower.

Suitable rotations and other management practices for Carlisle muck are given under management group 10 in table 10.

Carlisle silty muck (0 to 2 percent slopes) (Cb).—This separation differs from Carlisle muck in the high content of silty mineral material in the surface 8 to 15 inches. Natural drainage is very poor, but a large part of this soil is artificially drained to permit cultivation. The soil occurs in depressions or depressed flats, both on upland and terrace positions, usually closely associated with Carlisle muck. Native vegetation included reeds, sedges, and water-loving trees. Carlisle silty muck is mapped in small scattered areas, principally north of the Wabash River.

Profile characteristics in cultivated areas:

- 0 to 7 inches, very dark brownish-gray to nearly black granular silty muck containing a high percentage of mineral material that is well mixed with the organic matter; slightly acid.
- 7 to 12 inches, nearly black silty muck containing a somewhat lower percentage of mineral material than the above layer; slightly compact in place but breaks out into coarse soft granules; slightly acid.
- 12 to 18 inches, dark-brown to nearly black granular muck containing a small quantity of mineral material; slightly acid.
- 18 inches +, yellow and brown fibrous or macerated peaty and mucky material containing numerous partially decomposed remains of reeds, leaves, sedges, and other plant life; underlain at depths of 3 to 20 feet or more by sand, clay, or glacial till.

Variations are in color and thickness of the horizons and the content of mineral material in the first two horizons. The total thickness of the layers high in mineral material is 8 to 15 inches, and the thickness of the mucky and peaty material is 3 to more than 20 feet.

Use and management.—The drained areas, especially the smaller ones, are farmed in conjunction with Carlisle muck and other associated soils. Carlisle silty muck is well adapted to field corn, sweet corn, potatoes, and soybeans but is not so well adapted to small grains, although the new stiff-straw oat varieties may prove successful.

The principal crops are corn and vegetables; some areas are cropped to a rotation of corn, soybeans, oats, and hay crops. The soil is relatively high in organic matter and nitrogen. The supplies of phosphate and potash are low, however, and heavy applications of these elements are necessary for good corn yields. Soybeans are well adapted. Fall-sown small grains are occasionally damaged by excessive moisture in winter and spring, and small grains tend to lodge because of the high nitrogen content. Excellent stands of bluegrass are obtained on both the drained and undrained areas, although the livestock carrying capacity could be increased by mowing to remove the weeds.

Selected suitable management practices are given under management group 10 in table 10.

Coloma fine sand (3 to 15 percent slopes) (C_E).—This excessively drained soil occurs in small isolated areas. It is associated with Coloma loamy fine sand and Metea and Miami soils on undulating to rolling relief, usually as a slight elevation above the associated soils. Runoff is very slow, and internal drainage is very rapid because of the loose porous nature of the surface soil and subsoil. It occurs principally in the northeastern part of the county. The native vegetation consisted chiefly of black and white oaks.

Profile characteristics in cultivated areas:

- 0 to 8 inches, yellowish-brown to grayish-brown loose, single-grained fine sand; organic content very low; slightly to medium acid.
- 8 to 36 inches +, light brownish-yellow or yellowish-brown loose fine or medium sand; medium acid; extends to depths of 5 to 20 feet or more and underlain by medium- to light-textured calcareous glacial till.

Variations in the profile characteristics of Coloma fine sand are in the depth to the underlying glacial till.

Use and management.—Only a small area of this soil is mapped. Since it occurs in small tracts closely associated with Coloma loamy fine sand and Miami and Metea soils, cultivated areas are cropped like the associated soils. The principal crops are corn, wheat, and alfalfa and timothy hay. Crop yields are considerably below those obtained on Coloma loamy fine sand. The greater part of this soil is in low-grade pasture or forest. The latter use is probably most suitable. Good pastures are difficult to maintain, as they commonly burn out in the hot summer months.

Suitable crops and rotations are given under management group 3 in table 10.

Coloma loamy fine sand (3 to 15 percent slopes) (C_F).—This excessively drained soil is developed largely on loose sandy material. It is associated with Miami, Metea, and other soils and occurs mostly on a somewhat higher relief than the surrounding areas, occasionally in dunelike areas. The larger and more extensive tracts are in the northeastern part of the county. Owing to its porous nature, the material is very droughty. Wind erosion is frequently severe on the more rolling areas where a cover crop is not maintained. Here blowouts are frequent. The native vegetation consisted chiefly of black and white oaks.

Profile characteristics in cultivated areas:

- 0 to 8 inches, yellowish-brown to grayish, brown loamy fine sand that contains enough silt to give the material a very slight degree of coherence when moist; organic content low and usually only sufficient to stain the material slightly; slightly to medium acid.
- 8 to 36 inches, light brownish-yellow or yellowish-brown loamy fine sand with horizontal bands of yellow; medium acid.
- 36 to 50 inches +, light brownish-yellow or pale-yellow loose fine or medium sand; slight mottlings or blotchings of gray may occur in the lower part of this horizon.

Variations in the profile characteristics of Coloma loamy fine sand are in the color of the lower subsoil and in the thickness of the sandy material. Medium- to light-textured glacial till, composed of unassorted silt, clay, and rock fragments, occurs at depths of 5 to 20 feet or more.

Use and management.—This soil often occurs in areas of irregular size and shape and is often used for corn, wheat, and other crops. Except on the larger areas, the rotation is usually similar to that on

the associated Miami and Metea soils. This consists of corn, wheat or oats, and hay crops that usually include alfalfa and timothy with some clover.

Yields of corn are materially reduced in seasons of restrictive moisture conditions. Heavy fertilization with nitrogen, phosphorous, and potash is needed. Wheat is not well adapted and yields are low. Injury to wheat, as well as to other small grains, by blowing and shifting of the sandy surface is sometimes severe. Oats are not well adapted to this soil because of its droughtiness. Some oats are grown, however, but yields are usually low. Rye is probably better adapted than either wheat or oats but is grown only to a limited extent. Alfalfa produces fair yields after the soil has been limed sufficiently to bring the pH to 6.0 or higher. This crop tends to hold the surface soil in place and helps to prevent wind erosion. Blowouts, or areas where the wind has scooped out the surface and part of the subsoil, occur occasionally, and severe damage to young alfalfa plants may result. Clovers are not well adapted, and good stands are difficult to obtain.

The more rolling and steeper areas are probably better adapted to forests than to cultivated crops. Sizable tracts that occur on the steeper sloping areas have not been cleared of timber. A considerable portion of Coloma loamy fine sand is in permanent pasture, but the quality is only fair to poor. Good bluegrass pastures are difficult to maintain because of the droughtiness of this soil.

Suitable rotations and other management practices are given under management group 3 in table 10.

Conover fine sandy loam (0 to 2 percent slopes) (Cg).—This is imperfectly drained moderately dark-colored soil, developed on light-textured highly calcareous Wisconsin glacial till. It is closely associated with Crosby fine sandy loam and Brookston loam, principally in Boone Township. The organic-matter content of the surface soil is higher than in Crosby fine sandy loam but is somewhat lower than in the Brookston soils. Practically all areas are artificially drained to permit cultivation. Surface runoff is slow, and the movement of both water and air through the soil is moderate, provided drainage is adequate. The soil occurs on nearly level relief, usually with a gradient of less than 2 percent. The native vegetation consisted chiefly of sugar maple and elm and a smaller number of ash, sycamore, and white and black oaks.

Profile characteristics in cultivated areas:

- 0 to 7 inches, dark brownish-gray very friable fine sandy loam, relatively high in organic matter; slightly acid, although a few areas are medium acid.
- 7 to 11 inches, dark brownish-gray heavy fine sandy loam to sandy loam that is somewhat lower in organic-matter content than the above horizon; slightly to medium acid.
- 11 to 34 inches, mottled gray, yellow, and brown clay loam to light clay loam; breaks into subangular blocky aggregates from about $\frac{1}{8}$ to $\frac{3}{4}$ inch in diameter in the upper part of the horizon and from about $\frac{1}{2}$ to $1\frac{1}{2}$ inches in the lower part; permeable to moisture movements and to plant roots; slightly to medium acid in the upper part of the horizon and slightly acid to neutral in the lower part.
- 34 inches +, gray and yellow light-textured highly calcareous glacial till composed of unassorted silt, clay, sand, and rock fragments.

The variations in profile characteristics are in the organic content of the surface horizon and in texture and thickness of the various horizons. The depth to calcareous till varies from 24 to 40 or more inches. Where this soil grades into Crosby fine sandy loam, the surface color is somewhat lighter and the organic content lower than normal.

Use and management.—Crop rotations and treatments on this soil are similar to those in use on the closely associated Brookston loam and Crosby fine sandy loam. The common rotation includes corn, soybeans, wheat or oats, and hay crops. It is somewhat less well adapted to corn and soybeans than Conover loam because of the somewhat droughty nature of its surface soil and upper subsoil. Small grains are very well adapted, and where drainage is adequate and proper quantities of fertilizer are used, the yields are good. Most areas need small quantities of lime for the success of clover and alfalfa. These crops produce fairly good yields, although alfalfa is probably better adapted than clover.

Suitable rotations are given under management subgroup 5B in table 10.

Conover loam (0 to 2 percent slopes) (CH).—This is an imperfectly drained moderately dark colored soil developed on highly calcareous Wisconsin glacial till. It is closely associated with Crosby loam and fine sandy loam and with Brookston loam. The organic-matter content of the surface soil is higher than in the Crosby soils but is somewhat lower than in the Brookston soils. It occurs chiefly in Boone, Harrison, and Bethlehem Townships. Runoff and movement of water through the soil profile are slow, but most areas are artificially drained to permit cultivation. The soil is mapped in a position intermediate between Miami and Brookston soils, or in a position comparable to that of Crosby soils. The areas are often irregular in size and shape. The relief is nearly level, usually with a gradient of 2 percent or less. Natural vegetation consisted chiefly of sugar maple and elm and a smaller number of ash, sycamore, and white and black oaks.

Profile characteristics in cultivated areas:

- 0 to 7 inches, dark brownish-gray friable loam, relatively high in organic matter; usually slightly acid, although a few areas are medium acid.
- 7 to 11 inches, dark brownish-gray heavy loam to light silt loam that is somewhat lower in organic-matter content than the above horizon; coarse granular structure; slightly to medium acid.
- 11 to 32 inches, mottled gray, yellow, and brown silty clay loam to clay loam; breaks into subangular blocky aggregates from $\frac{1}{8}$ to $\frac{3}{4}$ inches in diameter in the upper part of the horizon and from $\frac{1}{2}$ to $1\frac{1}{2}$ inches in the lower part; slightly impermeable to moisture movements and to plant roots; slightly to medium acid in the upper part of the horizon and slightly acid to neutral in the lower part.
- 32 inches +, gray and yellow loam highly calcareous glacial till composed of unassorted silt, clay, sand, and rock fragments.

Variations in the profile characteristics of Conover loam are in the texture and thickness of the various horizons, the content of organic matter in the surface horizon, and the depth to calcareous till. The depth to till is 24 to 42 inches.

Use and management.—The crop rotation on Conover loam is similar to that on the associated soils. This includes corn, wheat or oats, and hay crops; or corn, soybeans, wheat or oats, and hay crops. Where

field units are composed largely of Conover loam, the rotation may be altered to include corn for 2 or more consecutive years.

This soil is well adapted to corn; but because of the close association with Crosby and other soils, it is impractical to alter the rotation to include more corn except where field units are composed largely of Conover loam or a combination of Conover and Brookston soils.

Wheat is well adapted to this soil if artificial drainage is adequate. Wheat, as well as other fall-sown small grains, is occasionally damaged by heaving and by excessive moisture. There is some damage to oats from lodging of the grain because of the relatively high organic-matter content of this soil. Soybeans are well adapted, and good yields are obtained under good management practices.

Suitable hay crops include a mixture of clover, alfalfa, timothy, alsike, and brome grass, or clover or alfalfa grown alone. Mixed hay and alfalfa have replaced clover to a large extent. Hay crops are occasionally damaged by heaving and by excessive moisture, but good yields are obtained where artificial drainage is adequate.

This soil produces excellent stands of bluegrass, but it is usually too valuable for cropland to remain in pasture. A few small scattered areas remain in timber.

For suitable rotations and other management practices see management subgroup 5A in table 10.

Crosby fine sandy loam (0 to 2 percent slopes) (Ck).—This light-colored soil was developed on light loam highly calcareous Wisconsin glacial till. It is an imperfectly drained member of the soil catena that also includes the well-drained Miami, poorly drained Bethel, very poorly drained dark-colored Brookston, and very poorly drained very dark-colored Kokomo soils.

Crosby fine sandy loam occurs in every township in the county north of the Wabash and the Eel Rivers; the larger areas occur north and east of Metea and in the northwestern part of the county. It is closely associated with Conover and Miami fine sandy loams and Brookston loam. Runoff and the rate of movement of water through the soil profile are slow. Most of the soil, however, has been artificially drained to permit cultivation. Native vegetation consisted chiefly of sugar maple, and beech and a smaller number of elm, ash, and white and black oaks.

Profile characteristics in cultivated areas:

- 0 to 7 inches, light brownish-gray to brownish-gray fine sandy loam relatively low in organic-matter content; slightly to medium acid.
- 7 to 10 inches, brownish-gray fine sandy loam to loam; medium acid.
- 10 to 36 inches, mottled gray, yellow, and brown sandy clay loam; breaks into subangular blocky aggregates from $\frac{1}{2}$ to $1\frac{1}{2}$ inches in diameter that can be easily crushed when moist but are hard when dry; medium acid.
- 36 inches+, gray and yellow light loam highly calcareous glacial till composed of unassorted silt, clay, sand, and rock fragments.

Variations in the profile characteristics are in the texture and thickness of the various horizons and in the depth to calcareous till. The depth to carbonates is 30 to 42 inches. The surface color is darker and the organic content higher than normal where Crosby fine sandy loam grades into Conover fine sandy loam or Brookston soils.

Use and management.—The same rotation and management practices are used on Crosby fine sandy loam as on the associated soils. Rotations include corn, wheat or oats, and hay crops; or corn, soybeans, wheat or oats, and hay crops. They are occasionally varied

to include rye and other field crops and an occasional vegetable crop. This soil is materially low in organic-matter content, and it is necessary that all available organic matter be plowed under to improve tilth as well as to increase the nitrogen content. Adequate artificial drainage is a prerequisite to successful cropping. Oats are not so well adapted to this soil as to the heavier textured Crosby soils, although a considerable acreage is grown each year.

Hay crops include a mixture of clover, alfalfa, timothy, alsike clover, and in some instances brome grass, or clover or alfalfa grown alone. To grow alfalfa successfully, it is necessary to apply sufficient lime to raise the pH to 6.0 or higher. Alfalfa is better adapted than clover, and clover grown alone has been replaced largely by alfalfa or mixed hay. Hay crops are occasionally injured by excessive moisture or by heaving. Average acre yields of hay crops are alfalfa, 1.5 tons, and mixed hay, 1.5 tons.

A considerable part of this soil is in relatively small fields of permanent pasture which consist mainly of bluegrass. Pastures can be materially improved by the use of sufficient lime and commercial fertilizer and by proper grazing. A small part is in forest.

Suitable rotations and other management practices are given under management subgroup 5B in table 10.

Crosby loam (0 to 2 percent slopes) (CL).—This is a light-colored soil developed on medium-textured, highly calcareous Wisconsin glacial till. It is an imperfectly drained member of the soil catena that also includes the well-drained Miami, poorly drained Bethel, very poorly drained dark-colored Brookston, and the very poorly drained very dark-colored Kokomo soils.

The soil is mapped northwest of Logansport, northeast of Metea, and in other small areas north of the Wabash and the Eel Rivers. It is usually associated with Miami loam and Brookston silty clay loam. The relief is nearly level. Most areas are artificially drained to permit cultivation. Native vegetation consisted chiefly of sugar maple and beech, and a smaller number of elm, ash, and white and black oaks.

Profile characteristics in cultivated areas:

- 0 to 7 inches, light brownish-gray to brownish-gray friable medium granular loam, relatively low in organic-matter content; slightly to medium acid.
- 7 to 10 inches, brownish-gray friable heavy loam to silt loam that has coarse granular structure; medium acid.
- 10 to 15 inches, mottled gray, yellow, and brown silty clay loam that breaks into subangular blocky aggregates $\frac{1}{8}$ to $\frac{3}{4}$ inch in diameter; horizon permeable to moisture movements and to plant roots; medium acid.
- 15 to 30 inches, mottled gray, yellow, and brown silty clay loam; breaks into well-developed subangular blocky aggregates $\frac{3}{4}$ to $1\frac{1}{2}$ inches in diameter that are easily crushed when moist but hard when dry; somewhat impervious to moisture and to plant roots; rock fragments as well as sand and gravel in varying quantities and an occasional large boulder; medium acid in the upper part and slightly acid in the lower few inches.
- 30 inches+, mottled gray, yellow, and brown loam to clay loam calcareous till composed of unassorted silt, clay, sand, and rock fragments.

Variations in the profile characteristics of Crosby loam are in the texture and thickness of the various horizons and in the depth to calcareous till. The depth to calcareous till varies from 24 to 40 inches. The areas of Crosby loam that are closely associated with areas of Conover loam and of Brookston soils may have a somewhat darker surface soil that is somewhat higher in organic-matter content than

normal. The boundaries between these soils may be arbitrarily drawn in some instances.

Use and management.—The greater part of Crosby loam is under cultivation to the general farm crops of the area. Special treatment is impracticable on this soil except where it forms a greater part of the field unit, since it occurs in areas of irregular size and shape, closely associated with Miami and Conover loams and Brookston soils. The common rotations are corn, wheat or oats, and hay crops; or corn, soybeans, wheat or oats, and hay crops. These rotations may be varied to include rye and other minor field crops and vegetable crops.

Provision for additional nitrogen, phosphorus, and potash must be made if high yields of corn are to be obtained. Good management includes the plowing under of all available manure, including green manure, and the use of sufficient lime to raise the pH to 6.0 or higher and of sufficient commercial fertilizer to meet the plant-nutrient requirements of the crop.

Wheat, as well as other fall-sown small grains, is occasionally damaged by heaving in winter and early spring, and the damage from excessive moisture is occasionally severe on areas where artificial drainage is inadequate. Soybeans are increasing in importance and are grown both for seed and for hay. Most of the increased acreage, however, has been largely for seed.

Hay crops consist of clover or alfalfa grown alone, or a mixture that includes these and timothy, alsike clover, and occasionally brome-grass. Clover grown alone has been largely replaced by a mixed seeding and by alfalfa grown alone. Hay crops are occasionally damaged by excessive moisture and by heaving of plants.

A small part of this soil is used for bluegrass pasture and good stands can be obtained. The permanent pastures can be considerably improved by the use of sufficient lime and commercial fertilizer. A few small areas are in forest.

Suitable rotations and other management practices are given under management subgroup 5A in table 10.

Crosby silt loam (0 to 2 percent slopes) (Cm).—This is light-colored soil developed on medium-textured highly calcareous Wisconsin till. It is an imperfectly drained member of the soil catena that also includes the well-drained Miami, poorly drained Bethel, very poorly drained dark-colored Brookston, and the very poorly drained very dark-colored Kokomo soils.

Crosby silt loam is associated with Miami silt loam and Brookston silty clay loam. The relief is nearly level. Most areas are artificially drained to permit cultivation. Surface runoff and internal drainage are slow. Native vegetation consisted chiefly of sugar maple and beech, and a smaller number of elm, ash, and white and black oak.

Profile description in cultivated areas:

- 0 to 7 inches, light brownish-gray to brownish-gray friable silt loam containing varying quantities of grit and small pebbles; composed of firm but not hard medium-sized crumbs that can be crushed easily when moist; organic-matter content variable but usually low (in undisturbed wooded areas the surface 2 to 3 inches is dark brownish-gray, relatively high in organic matter); slightly to medium acid.
- 7 to 10 inches, light brownish-gray friable silt loam that breaks into coarse granular aggregates; medium acid.

- 10 to 15 inches, mottled gray, yellow, and brown heavy silt loam to silty clay loam; breaks into small subangular blocky aggregates from $\frac{1}{4}$ to $\frac{1}{2}$ inch in diameter that are easily broken down into coarse granules when moist; numerous pebbles and an occasional boulder present; medium acid.
- 15 to 30 inches, mottled gray, yellow, and brown gritty silty clay loam; breaks into subangular blocky aggregates from $\frac{1}{2}$ to $1\frac{1}{2}$ inches in diameter; somewhat impervious to moisture movement; medium acid.
- 30 inches +, mottled gray, yellow, and brown loam to clay loam calcareous till composed of unassorted silt, clay, sand, and rock fragments; this represents the parent soil material.

Variations in the profile characteristics of Crosby silt loam are in the texture and thickness of the various horizons and the depth to calcareous till. Where Crosby silt loam grades into areas of Brookston silty clay loam, the surface soil is usually somewhat darker colored and is slightly heavier textured. Where it grades into Miami silt loam the surface soil approaches grayish-brown in color, and drainage conditions are somewhat better than normal. The reaction of the surface soil and subsoil in a few areas is only slightly acid.

Use and management.—The greater proportion of Crosby silt loam is under cultivation or is in bluegrass pasture. Since it is closely associated with Miami and Brookston soils and often occurs in small irregular-shaped areas, it is usually farmed about the same as the associated soils. The common rotation includes corn, wheat or oats, and hay. A rotation of corn, soybeans, wheat or oats, and hay is also in common use.

Hay crops include a mixture of clover, alfalfa, timothy, alsike clover, and brome grass, or clover or alfalfa grown alone. Adequate artificial drainage, lime, and commercial fertilizer are necessary for the success of clover and alfalfa. Good stands of bluegrass pasture are maintained on this soil, and they can be improved by the use of sufficient quantities of lime and commercial fertilizer, especially phosphate. Only small scattered areas are in forest.

Suitable crop rotations and other management practices are given under management subgroup 5A in table 10.

Delmar silt loam (0 to 2 percent slopes) (D₈).—This is a light-colored soil developed on a relatively thin covering (12 to 36 inches) of silt (probably loess) over highly calcareous medium-textured glacial till of Wisconsin age. It is a poorly drained member of the soil catena that also includes the well-drained Russell, imperfectly drained Fincastle, very poorly drained dark-colored Brookston, and very poorly drained very dark-colored Kokomo soils. Delmar silt loam occurs in close association with these soils. The relief is nearly level. Native vegetation included sugar maple, beech, elm, ash, and white and black oaks.

Profile description in cultivated areas:

- 0 to 7 inches, light-gray to gray friable smooth silt loam, low in organic-matter content; a few small, hard, rounded, brown or black iron concretions on the surface and throughout the horizon; medium to strongly acid.
- 7 to 10 inches, light-gray to gray smooth friable silt loam with a few pale-yellow blotches and numerous iron concretions; breaks into weak platy or coarse granular aggregates; medium to strongly acid.
- 10 to 15 inches, light-gray smooth silty clay loam mottled and blotched with pale yellow and yellowish brown; breaks into fine subangular blocky aggregates that are easily crushed when moist; medium to strongly acid.

- 15 to 36 inches, light-gray, mottled with yellow and brown, silty clay loam; breaks into coarse to very coarse subangular blocky aggregates that are firm when moist and hard when dry; upper part of layer usually smooth; content of grit and partially weathered rock fragments increases with depth; strongly to medium acid.
- 36 to 48 inches, mottled gray, yellow, and brown silty clay loam that is somewhat more friable than material in above horizon; content of pebbles and rock fragments variable but usually considerable; the structural aggregates range from coarse to very coarse subangular blocky, and are firm when moist and hard when dry; strongly acid above, grading to slightly acid in the lower 2 or 3 inches.
- 48 inches +, gray and pale-yellow highly calcareous clay loam to silt loam glacial till composed of unassorted silt, clay, sand, and rock fragments.

Delmar silt loam varies from the above description in the thickness, color, and texture of the various layers and in the depth to calcareous till. The silty surface and upper subsoil layers are wind-deposited material. The thickness of this material is not uniform, hence the variability of the texture of the surface and upper subsoil. Where Delmar silt loam grades into Brookston soils, the color of the surface soil is darker and the organic-matter content is higher than normal; where it grades into Fincastle soils, the color of the surface soil is light brownish-gray and drainage conditions are somewhat better than normal. The depth to calcareous till varies considerably from 36 to 75 inches or more.

Use and management.—Delmar silt loam is relatively low in natural fertility. Artificial drainage is necessary for successful crops. It is essential that all available organic matter, including barnyard manure and green manure crops, be turned under, and that liberal quantities of commercial fertilizer and sufficient lime be used in order to maintain and increase productivity of this soil. It is not well adapted to oats, as planting is often delayed in spring, and the crop suffers from lack of moisture in summer. Good stands of clover and alfalfa are difficult to obtain without additions of lime, and there is considerable injury to these crops from drowning out and heaving.

The principal crop rotation includes corn, oats or wheat, soybeans, and hay crops, usually a legume-grass mixture. A part of this soil is in permanent bluegrass pasture. The pasture could be improved by use of lime and fertilizer and by controlling weeds.

Suitable crop rotations and other suggestions on soil management are given under management group 6 in table 10.

Delmar-Bethel silt loams (0 to 2 percent slopes) (DA).—This complex includes two poorly drained light-colored soils—Delmar silt loam and Bethel silt loam—occurring in such close association that separation is impractical. The profile characteristics in practically all areas range between those of the two soils. The texture and thickness of the various horizons, as well as the depth to calcareous till, are quite variable within short horizontal distances and from place to place. The siltiness of the upper horizons indicate that the parent materials included a mantle of silt, the thickness varying in short distances. This accounts for some of the variability in the profile. Furthermore, in some areas the till is sandier than normal for these soils, and there is evidence of some local water assorting.

Use and management.—Artificial drainage is necessary for successful crop production. Most areas have been drained, but some are in need of more adequate drainage. The organic-matter and nitrogen

contents are low, and any rotation in use should include a large proportion of cover crops and legumes. Delmar-Bethel silt loams warm up late in spring, and planting may be delayed not only on these but on associated soils, since this separation usually comprises only a small part of a field unit. The crop rotation in general use includes corn, wheat or oats, soybeans, and hay. Small grains and hay crops are occasionally damaged from drowning out. A considerable part of this complex is idle during years of excessive moisture conditions.

Suitable rotations and other management practices are given under management group 6 in table 10.

Dillon fine sandy loam (0 to 2 percent slopes) (Dc).—This soil was developed on acid sands of Wisconsin age. It is the very poorly drained, very dark-colored member of the soil catena that also includes the excessively drained Plainfield, moderately well drained Berrien, imperfectly drained Morocco, and very poorly drained dark-colored Newton soils. Morocco soils are not extensive enough in this county to be mapped separately. Dillon fine sandy loam occurs in the deeper depressions and deeper depressed flats in the northwestern part of the county, associated with Plainfield, Berrien, Newton, and in some instances Maumee soils. The relief is nearly level, and most of the rainfall is removed internally. Artificial drainage is necessary for cropping. Most areas of this soil are not drained sufficiently to be used for cultivated crops. The native vegetation included water-loving trees, sedges, reeds, and grasses.

Profile description in cultivated areas:

- 0 to 7 inches, very dark-gray to nearly black very friable fine sandy loam relatively low in organic-matter content; strongly to very strongly acid.
- 7 to 18 inches, very dark-gray to dark-gray loose loamy sand to fine sand relatively high in organic-matter content; an occasional thin layer of slightly heavier textured material in some areas; strongly to very strongly acid.
- 18 inches +, gray loose sand containing a few small rounded pebbles in some areas; below a depth of 30 to 40 inches the color changes to mottled gray, yellow, and brown; strongly acid to a depth of 5 feet or more.

The variations are in the color, organic-matter content, and thickness of the first two horizons.

Use and management.—A large proportion of Dillon fine sandy loam is at present in forest or permanent pasture. These areas have not been drained sufficiently to permit cropping. The organic-matter content and nitrogen supply of the uncultivated soil are relatively high, but the soil is somewhat deficient in phosphate and potash. Heavy applications of lime are needed to correct the strong acidity.

The principal crops are corn, soybeans, and timothy; minor acreages of wheat and some minor field crops and an occasional vegetable crop are grown. Soybeans usually follow corn in the rotation. It is difficult to obtain a good stand of clover or alfalfa even after heavy applications of lime. Timothy is the principal hay crop and appears to tolerate the strong acidity somewhat better than other hay crops. The water table has been lowered to such an extent on some areas that the soil is droughty, and crops suffer during periods of low moisture in late summer and early fall. Permanent pasture is usually of low quality, and bluegrass makes up a small part of the vegetation.

Heavy applications of fertilizer are needed for all crops.

Suitable crop rotations and other soil management practices are given under management group 9 in table 10.

Eel loam (0 to 2 percent slopes) (Ea).—This is a moderately well to imperfectly drained soil developed on neutral to slightly alkaline alluvium from upland and terrace areas of Wisconsin glacial drift. It occurs on nearly level relief of the first bottoms or flood plains and is mapped principally in the northern part of the county. It often is the principal or only soil in the flood plains of the smaller drainageways. The native vegetation included predominantly sycamore, ash, and elm.

The profile characteristics of Eel loam are similar to those of Eel silt loam except that the surface texture is loam and the texture of the upper subsoil is somewhat lighter.

Use and management.—The greater part of this soil is at present in permanent bluegrass pasture or in forest. The pastures are of good to excellent quality, although many could be improved by weed-control. Cultivated areas are cropped principally to corn and soybeans and minor quantities of small grains, alfalfa, and clover. The soil is better adapted to corn and soybeans than to small grains, which suffer loss from flooding. Good stands of alfalfa and clover can be obtained, but there is loss from flooding where the areas are not protected. A few small areas are in sweet corn and other vegetables.

Suitable crop rotations and other management practices are given under management group 12 in table 10.

Eel silt loam (0 to 2 percent slopes) (Eb).—This moderately well-drained to imperfectly drained soil was developed on neutral to slightly alkaline alluvium from upland and terrace areas of calcareous Wisconsin drift. It is on the flood plains or first bottoms of the rivers and streams of the county, except in the northern and northwestern parts. The soil occurs in temporary channels made by floodwaters, and it is often the dominant soil along small drainageways. It also occurs in the areas farthest removed from the stream channel along the larger streams and rivers. The native vegetation consisted chiefly of sycamore, elm, and ash.

Profile description in cultivated areas:

- 0 to 7 inches, light yellowish-brown to brownish-gray friable granular silt loam; organic matter content variable but usually low; neutral.
- 7 to 20 inches, light brownish-yellow to pale-yellow friable coarse granular heavy silt loam to silty clay loam; a somewhat platy structure; an occasional thin layer of fine sand present; neutral.
- 20 inches +, mottled gray and yellow silty clay loam to sand and gravel; a wide variation in composition and numerous depositional horizons can be distinguished; in some areas, chiefly sand and gravel below a depth of 40 inches; neutral to calcareous.

Variations in the profile characteristics of Eel silt loam are in the color, texture, and thickness of the various horizons.

Use and management.—Most of the areas occurring in the flood plains of the Eel and the Wabash Rivers and in the larger streams of the county are under cultivation. Most of those in the flood plains of the smaller streams and drainageways are in permanent pasture or forest. Rotations are similar to those in use on Genesee soils except where a field unit comprises a large part or all of this soil. Rotations on such areas include corn, soybeans, alfalfa, clover, and wheat, and to a lesser extent oats and vegetable crops. Crop loss from flooding is more severe on this soil than on the better drained Genesee soils, especially in those areas occurring in the old abandoned channels.

Corn is often grown for 2 or more consecutive years. Small grains are not well adapted because of the hazard of flooding, although they are occasionally grown, especially on areas of this soil that are closely associated with Genesee soils. Loss from flooding is sometimes severe. Oats are not well adapted, and only a small total acreage is grown. The vegetable crops, especially sweet corn, are grown rather extensively in some years. Alfalfa and clover can be grown without the addition of lime, and good yields are obtained where the soil is protected from flooding. The danger to these crops from flooding is also potentially great. Excellent bluegrass pastures are obtained without the use of lime and are often the principal use made of this soil where it occurs along the small drainageways and flood plains of the smaller streams.

Suitable crop rotations and other management practices are given under management group 12 in table 10.

Farmington silt loam (1 to 4 percent slopes) (Fa).—This well-drained soil was developed on thin deposits of Wisconsin glacial drift overlying nearly horizontal beds of limestone. It occurs on nearly level to sloping relief on benchlike areas adjacent to the Wabash River and Pipe Creek. Farmington silt loam is associated with Milton and Millsdale soils and Limestone rockland; it grades into Limestone rockland where the depth to limestone is shallower and into Milton silt loam in areas where the depth to bedrock is deeper. Bedrock of limestone outcrops here and there. These outcrops are indicated on the soil map by rock outcrop symbols. Water moves through the profile at a moderate rate, although the moisture storage capacity is very limited because of the shallow depth to bedrock.

Profile description in cultivated areas:

- 0 to 6 inches, dark grayish-brown to very dark brown friable medium-granular silt loam; grayish.
- 6 to 11 inches, yellowish-brown to very dark brown silt loam to silty clay loam; firm when moist; coarse granular to medium subangular blocky structure; numerous partially decomposed limestone fragments in the lower inch or two of this horizon; neutral to alkaline.
- 11 inches +, limestone bedrock.

The content of organic matter in the surface layer is variable; in some areas it is relatively high. The thickness of the surface soil and subsoil, or the depth to limestone bedrock, varies from 8 to 16 inches within short horizontal distances. Outcrops of bedrock occur here and there throughout the areas.

Use and management.—This soil is essentially nonagricultural, and more than 98 percent is in permanent pasture, trees, or shrubs. A few areas are cropped to corn, but yields are extremely low. The quality of the bluegrass pasture is quite variable and depends upon the thickness of the surface and subsoil horizons. The soil is better adapted to forest or to permanent pasture than to cultivated crops.

Suitable management practices are given under management subgroup 1D in table 10.

Fincastle silt loam (0 to 2 percent slopes) (Fc).—This light-colored soil developed on a related thin mantle (12 to 36 inches +), probably loess overlying highly calcareous Wisconsin glacial till. It is the imperfectly drained member of the soil catena that also includes the well-drained Russell, the poorly drained Delmar, the very poorly drained dark-colored Brookston, and the very poorly drained very

dark-colored Kokomo soils. Fincastle silt loam occurs on nearly level to gently undulating relief in close association with Brookston and Russell soils. Surface runoff is slow. Practically all the areas have been drained sufficiently to permit cultivation. A few areas, however, are in need of more adequate drainage. This soil is similar to Crosby silt loam in natural drainage conditions but differs principally in the smoother, more silty nature of the surface soil and upper subsoil horizons; the strong acidity of the subsoil; and the greater depth to calcareous till. The native vegetation consisted principally of beech, sugar maple, elm, blackgum, and white, black, and pin oaks.

Profile description in cultivated areas:

- 0 to 7 inches, light brownish-gray smooth friable granular silt loam, relatively low in organic-matter content; in undisturbed wooded areas the surface 1 to 2 inches is dark brownish gray and relatively high in organic-matter content; medium acid.
- 7 to 10 inches, light brownish-gray, smooth friable silt loam; composed of firm but not hard medium to coarse granules; and very little grit and pebbles present; a few faint light-yellow mottlings may be present; medium to strongly acid.
- 10 to 16 inches, mottled gray, yellow, and brown smooth silty clay loam that breaks into small subangular aggregates from $\frac{1}{2}$ to $\frac{3}{4}$ inch in diameter; only a small quantity of grit and pebbles present; medium to strongly acid.
- 16 to 35 inches, mottled gray, yellow, and brown heavy plastic silty clay loam that breaks into subangular aggregates from $\frac{3}{4}$ to $1\frac{1}{2}$ inches in diameter; somewhat impermeable to moisture and to plant roots; strongly to medium acid.
- 35 to 46 inches, mottled gray, yellow, and brown silty clay loam containing increasing quantities of grit, pebbles, and rock fragments with depth; more friable than the above horizon and not so impermeable to moisture and plant roots; medium to slightly acid.
- 46 inches +, gray and yellow compact calcareous loam to coarse clay loam till composed of unassorted silt, clay, sand, and rock fragments; this represents in part the parent soil material.

There is considerable variation in the thickness of the various horizons and the depth to calcareous till. Where Fincastle silt loam grades into Brookston silty clay loam, the surface soil is somewhat darker colored and slightly heavier textured. The profile characteristics in numerous small areas approach those of Crosby silt loam, but the depth to calcareous till is much greater. There is some evidence of local stratification in some spots. Here the depth to calcareous till is greater than normal.

Use and management.—The greater portion of Fincastle silt loam has been cleared of timber and is either cropped or in bluegrass pasture. This soil occurs in very close association with Brookston and Russell soils, especially south of the Wabash River, and most field units include several individual areas of these soils. Management practices and rotations in use are therefore necessarily very similar to those for the associated soils. Since the surface soil and subsoil horizons are more acid than those of Crosby soils, a greater quantity of lime is needed for the success of legumes. Fincastle silt loam is normally low in organic matter and nitrogen, and management practices should include the turning under of all available organic matter to improve both the tilth conditions and the moisture-holding capacity. The rotation in common use includes corn, wheat or oats, soybeans, and hay crops, including alfalfa grown alone or a mixture of alfalfa, clover, alsike, and timothy. This is occasionally altered to include special field or hay crops and vegetable crops.

Corn usually follows hay crops in the rotation or it may occasionally follow other crops, especially where winter-sown small grains have been winterkilled. Excellent yields of corn are obtained under good management practices, which include the liberal use of barnyard and green manure; use of sufficient quantities of commercial fertilizer and lime; and a rotation system that includes less corn and more clover and alfalfa.

Wheat generally follows corn or soybeans in the rotation. There is some damage to wheat from heaving and drowning out in winter and early spring, although the extent of this damage is never great. Because of this hazard, oats is sometimes used in place of wheat in the rotation. Hay crops, including either alfalfa grown alone or a hay mixture, usually follow small grains. Application of lime is necessary for the success of either alfalfa or clover. These legumes are well adapted providing lime and fertilizer are used and drainage is adequate. A small part of the soil is in permanent bluegrass pasture. The quantity and livestock-carrying capacity of the pastures could be increased by use of sufficient lime and phosphate fertilizer and weed control. Only a small proportion remains in forest.

See management subgroup 5A in table 10 for suggestions of suitable management practices.

Fincastle-Crosby silt loams (0 to 2 percent slopes) (Fb).—This complex includes areas where Fincastle silt loam and Crosby silt loam occur in such close association that it is impractical to separate the individual soils. The profile characteristics in practically all areas range between those of the two soils. It is probable that wind-blown silts, or loess, have been deposited on the surface in variable thickness from place to place and within short horizontal distances. The thickness and texture of the various horizons, as well as the mineralogical content and depth to calcareous till, are variable. The depth to calcareous till is 34 to 75 inches or more within individual areas. Parts of numerous areas have sandy lower subsoils and sandy to loam-textured calcareous till at depths of 60 to 70 inches or more. The boundary line between this separation and Fincastle silt loam is drawn somewhat arbitrarily, and areas having these complex characteristics may occur within the areas of Fincastle silt loam.

Use and management.—The greater part of this separation is under cultivation, chiefly to corn, wheat, oats, soybeans, and hay crops, including alfalfa, clover, and timothy. Artificial drainage is necessary for successful crops. These soils are low in organic-matter content, and all available barnyard manure and green manure should be turned under, not only to increase the supply of organic matter but also to improve the tilth and ability of the soil to retain moisture. Liming is usually necessary for the success of clover and alfalfa. A part of this separation is in permanent bluegrass pasture. The quality of the pasture is variable, and the livestock-carrying capacity of most of the areas could be increased by liming, fertilizing, and control of weeds.

Suggestions on suitable management practices, are given under subgroup 5A in table 10.

Fox fine sandy loam (0 to 3 percent slopes) (Fd).—This is a light-colored soil developed on highly calcareous glaciofluvial gravel and sand of Wisconsin Age. It is a well-drained to somewhat excessively drained member of the soil catena that also includes the moderately

well-drained Bronson, imperfectly drained Homer, very poorly drained dark-colored Westland, and the very poorly drained very dark-colored Abington soils. It occurs on nearly level to gently undulating relief. Surface runoff is slow, and permeability is moderate to rapid. Erosion is slight. The more extensive areas are mapped in the eastern part of the county north of the Eel River. Native vegetation was an oak-hickory association.

Profile description in cultivated areas:

- 0 to 7 inches, grayish-brown to light-brown fine sandy loam, low in organic-matter content; slightly to medium acid.
- 7 to 20 inches, brown to yellowish-brown sandy loam to loam that breaks into coarse granular aggregates; a few small pebbles and an occasional large rounded boulder; slightly to medium acid.
- 20 to 34 inches, weak reddish-brown to brown waxy and gravelly clay loam to sandy clay loam that breaks into pieces of irregular shape and size; slightly plastic when moist and hard when dry; considerable small rounded stones throughout the horizon; medium to slightly acid.
- 34 to 40 inches, dark-brown to dark grayish-brown gravelly clay loam; breaks into large irregular shaped chunks that become hard when dry; neutral; tongues or lenses of this material extend downward into the underlying horizon.
- 40 inches +, gray and light-yellow highly calcareous stratified gravel with some sand.

Variations in the profile characteristics are in the thickness and color of the various horizons and the depth to calcareous gravel. Where Fox fine sandy loam grades into the deep phase, the depth to gravel is somewhat greater than normal. Where it grades into Fox loam, the texture of the surface and upper subsoil horizons is slightly heavier than normal.

Use and management.—The rotation in general use on this soil includes corn, wheat, soybeans, and hay crops, principally alfalfa. A few areas are used for special crops such as tomatoes, sweet corn, and other vegetables, but the total acreage is never large.

It is essential that all organic material available be applied to this soil in order to maintain the proper physical condition and to improve productivity.

Fox fine sandy loam is better suited to wheat and rye than to oats because of the dry condition that usually exists late in spring and in summer. Wheat usually follows corn in the rotation. Some areas receive a topdressing of barnyard manure during winter and early spring, although this is not a general practice. Oats are grown to a limited extent and usually take the place of wheat in the rotation.

Hay crops include a mixture of clover, alfalfa, timothy, alsike, and brome grass, or alfalfa grown alone. Alfalfa is better suited than clover or other hay crops. A few areas are under cultivation to vegetables. These usually receive rather heavy applications of commercial fertilizer.

A few areas are in permanent bluegrass pasture of fair to good quality. Most of the permanent pastures, however, can be materially improved by the use of sufficient lime and commercial fertilizers, especially phosphate and by systematic mowing to control weeds.

Suitable management practices are given under management subgroup 2B in table 10.

Fox fine sandy loam, deep phase (0 to 3 percent slopes) (Fe).—The deep phase differs from the normal phase of Fox fine sandy loam principally in the greater depth to loose gravel. It occurs on nearly level

to gently undulating relief in close association with the normal phase. The larger areas are mapped near Hoover. Surface runoff is slow, and permeability, or movement of moisture through the soil, is moderate to rapid. This phase is not so droughty as Fox fine sandy loam because of the greater thickness of the surface and subsoil materials. Native vegetation included an oak-hickory association.

Profile description in cultivated areas:

- 0 to 7 inches, grayish-brown to light-brown fine sandy loam low in organic-matter content; slightly to medium acid.
- 7 to 20 inches, brown to yellowish-brown sandy loam to loam that breaks into coarse granular aggregates; a few small pebbles and an occasional large rounded boulder; slightly to medium acid.
- 20 to 54 inches, weak reddish-brown to brown waxy and gravelly clay loam that breaks into pieces of irregular shape and size; slightly plastic when moist and hard when dry; considerable small rounded stones throughout the horizon; medium acid.
- 54 to 60 inches, dark-brown to dark grayish-brown gravelly clay loam; breaks into large irregular-shaped chunks that become hard when dry; neutral; tongues or lenses of this material extend downward into the underlying horizon.
- 60 inches +, gray and yellow highly calcareous stratified gravel with some sand.

Use and management.—Fox fine sandy loam, deep phase, is cropped about the same as the normal phase. It is closely associated with the normal phase, and often a field unit includes both; thus management practices are necessarily similar. Crop yields, however, are somewhat higher on the deep phase because of the better moisture relationships.

Suitable management practices are given under management subgroup 2B in table 10.

Fox loam (0 to 7 percent slopes) (Ff).—This is a light-colored soil developed on highly calcareous glaciofluvial gravel and sand of Wisconsin Age. It is a well-drained to somewhat excessively drained member of the soil catena that also includes the moderately well-drained Bronson, imperfectly drained Homer, very poorly drained dark-colored Westland, and the very poorly drained very dark-colored Abington soils. The relief is nearly level to gently sloping. Surface runoff is slow, and permeability, or the movement of moisture and air through the soil, is moderate to rapid. Native vegetation included primarily an oak-hickory association.

Profile characteristics in cultivated areas:

- 0 to 7 inches, grayish-brown to brown friable loam relatively low in organic-matter content; a variable but considerable content of rounded pebbles; breaks into medium granules that are friable when moist and slightly hard when dry; slightly to medium acid.
- 7 to 18 inches, brown or yellowish-brown friable heavy loam to a depth of 12 inches and silty clay loam below; a considerable number of rounded glacial pebbles; breaks into fine to medium subangular blocky aggregates that are slightly firm when moist and slightly hard when dry; medium acid.
- 18 to 32 inches, weak reddish-brown gravelly clay loam containing considerable rounded stones and an occasional boulder; breaks into irregular-sized angular chunks that are sticky when wet, firm to slightly plastic when moist, and hard when dry; medium acid.
- 32 to 38 inches, dark-brown to dark grayish-brown (often with a slightly reddish hue) gravelly clay loam containing numerous rounded stones; breaks into irregular-sized angular pieces that are sticky when wet, plastic when moist, and hard when dry; an abrupt change from the above horizon to this material and from this horizon to the underlying material;

V-shaped tongues, varying in length from 2 to 12 or more inches, extend downward below the general level of the upper boundary of the horizon below; neutral.

38 inches +, gray and yellow loose highly calcareous stratified gravel with some sand.

Variations are in the thickness and texture of the different horizons and in the depth to loose calcareous gravel. Included are a few small areas that have a slope of 3 to 8 percent. Also included are a few areas that have a gravelly loam surface texture and enough rounded gravel to interfere with cultivation. These areas would have been separated on the map as Fox gravelly loam if they had been of sufficient extent.

Use and management.—The principal crops include corn, wheat, alfalfa, and vegetables; although oats, soybeans, and other hay crops are also grown to a limited extent. This soil is naturally low in organic-matter content, and constant replenishment is necessary for maintenance and improvement of productivity.

Oats are not so well adapted as wheat because of the somewhat droughty condition that often exists late in spring and in summer. Alfalfa is the principal hay crop and is well adapted to this soil, but additions of sufficient lime are necessary to insure a good stand. Alfalfa will withstand the somewhat droughty conditions that often exist in summer. Hay crops occasionally include a mixture of clover, timothy, and alfalfa. Soybeans are gaining in importance on this soil and usually follow corn in the rotation. Permanent bluegrass pasture is of fair to good quality, but it can be improved materially by the use of sufficient lime and phosphate and by mowing the areas to control weeds. A few small areas are in timber.

Suitable management practices are given under management sub-group 2A in table 10.

Fox loam, steep phase (18 to 30 percent slopes) (Fg).—This phase usually occurs in narrow elongated areas of the normal phase of Fox loam and alluvial soils, or between different levels of Fox soils. Surface runoff is rapid, and the soils are droughty because of the steep sloping condition. The profile characteristics are similar to those of Fox loam except that the horizons are considerably thinner and the depth to calcareous gravel is 16 to 25 inches.

Use and management.—The greater part of this phase is in forest. A few areas, however, have been cleared and are either in cultivation or in pasture at the present time. These cleared areas are usually severely eroded, and an occasional gully extends into the loose gravel. This phase is essentially nonagricultural, and the best use is probably for forest.

Suitable management practices are given under management sub-group 1C in table 10.

Fox silt loam (0 to 5 percent slopes) (Fh).—This soil was developed on highly calcareous glaciofluvial gravel and sand of Wisconsin Age. It is a well-drained to somewhat excessively drained member of the soil catena that also includes the moderately well drained Bronson, the imperfectly drained Homer, the very poorly drained dark-colored Westland, and the very poorly drained very dark colored Abington soils. It occurs on nearly level to gently undulating relief on terraces and high benches, adjacent principally to the Wabash and the Eel Rivers and to a lesser extent to Deer Creek and other small streams in the county. Surface runoff is slow, and the movement of moisture

through the soil is moderate to rapid. Erosion is slight. Native vegetation included principally an oak-hickory association.

Profile characteristics in cultivated areas:

- 0 to 7 inches, grayish-brown to brown friable silt loam, relatively low in organic-matter content; medium to slightly acid.
- 7 to 18 inches, brown or yellowish-brown heavy silt loam to silty clay loam containing a considerable quantity of rounded gravel and an occasional large rounded boulder; breaks into medium subangular blocky aggregates that are slightly firm when moist and slightly hard when dry; medium acid.
- 18 to 32 inches, weak reddish-brown to brown gravelly clay loam that breaks into irregular-sized angular pieces that are slightly plastic when wet and hard when dry; content of gravel and rounded stones is variable but usually relatively high; medium acid.
- 32 to 37 inches, dark-brown compact gravelly clay loam; breaks into irregular-shaped pieces that may be broken down when moist into small angular pieces; content of gravel and small rounded stones relatively high; an abrupt change from the above horizon to this material and from this horizon to the underlying material; V-shaped tongues varying in length from 2 to 10 inches or more extend downward into the horizon below; neutral.
- 37 inches +, gray and light-yellow highly calcareous stratified gravel with some sand.

Variations are in the depth and thickness of the various horizons and the depth to calcareous gravel. Included are small areas in slight depressions within the larger areas of Fox silt loam. These small areas have a darker colored surface soil than normal. Where Fox silt loam grades into the deep phase, the depth to calcareous gravel is greater than normal.

Use and management.—The rotation system on this soil includes corn, wheat or oats, soybeans, and hay crops, including alfalfa alone or a mixture of alfalfa, clover, timothy, and alsike. A limited acreage is used also for truck crops, principally sweet corn and tomatoes. The surface soil is relatively low in organic-matter content, and any management program should include the plowing under of all available organic matter, including barnyard and green manures, and the use of sufficient lime and commercial fertilizer.

Corn usually follows hay crops in the rotation, although it may be grown where small grains have failed. Fertilizers containing nitrogen, phosphorus, and potassium are usually needed for maximum yields. Moisture conditions late in summer and early in fall are occasionally unfavorable, and corn yields are materially reduced. Wheat is well adapted to this soil. Oats are not so well adapted as wheat because of the unfavorable moisture conditions in the growing season. The acreage used for soybeans has increased in recent years, and the crop usually follows corn or small grains in the rotation.

Alfalfa is better suited than other hay crops because it can withstand the somewhat droughty condition late in summer and early in fall. Sufficient lime is necessary for the success of alfalfa. Heavy applications of fertilizer at the time of sowing small grains will help materially to assure good stands of alfalfa as well as other hay crops. Clover is less well adapted than alfalfa, and only a few areas of clover alone are grown.

A few areas are in permanent bluegrass pasture. The quality and livestock-carrying capacity of the pastures can be increased by application of sufficient lime and phosphate and by weed control. Only a small total acreage is in forest.

Management suggestions are given under subgroup 2A in table 10.

Fox silt loam, deep phase (0 to 5 percent slopes) (Fk).—The deep phase differs from the normal phase of Fox silt loam principally in the smoother and siltier nature of the surface soil and upper subsoil and the greater depth to loose calcareous gravel. It occurs on high terrace areas south of the Wabash River on nearly level to gently sloping relief. It is well drained. Surface runoff is slow except on the sloping areas, and the rate of movement of moisture and air through the profile is moderate.

Profile description in cultivated areas:

- 0 to 7 inches, grayish-brown to brown smooth friable silt loam relatively low in organic matter; medium firm but not hard crumb structure; very little gritty material or pebbles; medium acid.
- 7 to 16 inches, brown or yellowish-brown smooth friable heavy silt loam; breaks into fine subangular blocky to coarse crumb aggregates that are friable when moist and firm when dry; very little grit or pebbles present; medium to strongly acid.
- 16 to 50 inches, brown to weak reddish-brown silty clay loam; breaks into well-developed medium to coarse subangular blocky aggregates that are firm when moist and hard when dry; very little gravel and grit in the upper part of the horizon but the quantity increases with depth; medium to strongly acid.
- 50 to 56 inches, dark-brown waxy and gravelly clay loam that breaks into large angular chunks; slightly plastic when moist and hard when dry; V-shaped tongues of this material extend downward into the underlying horizon; neutral.
- 56 inches +, gray and light-yellow calcareous stratified gravel and coarse sand.

Variations are in the color, thickness, and texture of the horizons and the depth to calcareous gravel. Where this phase grades into the normal phase of Fox silt loam, the depth to gravel is somewhat less than normal. The substrata in places includes gravel, sand, boulders, and silt that are not well assorted.

Use and management.—The principal crops include corn, wheat, soybeans, alfalfa, and mixed hay and lesser quantities of vegetables, oats, and special field and hay crops. This soil is naturally low in organic matter, and all available crop residue and green manure crops should be plowed under. A complete fertilizer is also needed for most crops.

Wheat is well adapted and usually follows corn or soybeans in the rotation. Soybeans generally follow corn or small grains. Oats are not so well adapted as wheat, although they are somewhat better adapted to this phase than to the normal phase of Fox silt loam.

Hay crops include alfalfa grown alone or a mixture of alfalfa, clover, timothy, alsike, and occasionally brome grass. It is necessary to apply sufficient lime to this soil for the success of alfalfa and clover. The areas having the stronger slopes are probably better suited to alfalfa than to cultivated crops.

A few areas are in permanent bluegrass pasture, which could be improved by the use of phosphate fertilizer, lime, and proper weed control. Most of the sloping areas are in forest.

Detailed suggestions on suitable management practices are given under management subgroup 2A in table 10.

Genesee fine sandy loam (0 to 2 percent slopes) (Ga).—This is a well-drained soil developed on neutral to slightly alkaline alluvium from upland and terrace regions of Wisconsin glacial drift. It occurs on nearly level relief, principally in the flood plains of the Eel and

the Wabash Rivers and to a lesser extent on the flood plains of the smaller streams of the county. The native vegetation included deciduous trees; elm and sycamore were the prominent species.

Profile description in cultivated areas:

- 0 to 7 inches, grayish-brown to medium-brown very friable fine sandy loam; organic content variable but usually low; neutral.
- 7 to 30 inches, brown or yellowish-brown fine sandy loam to loam; neutral to slightly alkaline.
- 30 inches +, yellowish-brown to brown stratified layers of fine sandy loam, loam, and sand; layers of fine gravel below a depth of 40 or 48 inches in some places; calcareous.

The variations are in the organic-matter content of the surface soil and in the texture of the subsoil and substrata.

Use and management.—Genesee fine sandy loam is not extensively mapped and occurs in close association with Genesee loam; it is therefore farmed in almost the same manner. Crops include corn, soybeans, wheat, alfalfa, and sweetclover and some vegetables and minor field crops. Yields of most crops are somewhat lower than those obtained on Genesee loam. A considerable proportion is in permanent bluegrass pasture or forest. It is somewhat less well adapted to general farm crops than either Genesee silt loam or loam.

Suitable crop rotations and other management practices are given under management group 11 in table 10.

Genesee loam (0 to 2 percent slopes) (Gb).—This is a well-drained soil developed on neutral to slightly alkaline alluvium from upland and terrace regions of Wisconsin glacial drift. It occurs on nearly level relief on flood plains of the county, principally along the Wabash and the Eel Rivers and Pike and Deer Creeks. It is often adjacent to the stream channel and is associated with Eel soils that occur in the areas farther removed from the stream. The soil is subject to periodic flooding, and practically all of the areas are flooded about once a year. Native vegetation included deciduous forest; elm and sycamore were prominent species. Genesee loam is similar to Genesee silt loam in profile characteristics, except that the surface texture is loam and the upper subsoil texture is usually somewhat lighter.

Use and management.—The greater part of Genesee loam is under cultivation. The principal crops include corn, soybeans, wheat, sweetclover, alfalfa, and sweet corn, although some oats and other field crops and a variety of vegetables are occasionally grown. The rotation varies. It may include corn for 2 years and soybeans; corn, wheat, and hay crops; or corn, vegetables, and soybeans. Sweetclover occasionally is used as an intercrop to be turned under for green manure. Corn and soybeans are both well adapted. Wheat is well adapted, but there is always the danger of damage from floodwaters. Oats are grown to a limited extent.

Both alfalfa and clover are well adapted, and excellent stands are obtained without the use of lime. Serious loss to the crop may occur, however, because of flooding. Sweet corn is the principal crop, although a variety of other vegetables are grown on areas close to Logansport. Excellent stands of bluegrass pasture are obtained, although only a small part of the areas are in this use. A few areas in the smaller stream bottoms and adjacent to the larger streams remain in timber.

Suitable management practices are given under management group 11 in table 10.

Genesee silt loam (0 to 2 percent slopes) (Gc).—This well-drained soil developed on alluvium derived from upland and terrace areas of calcareous Wisconsin glacial drift. It is on nearly level relief in the flood plains of the rivers and streams in all parts of the county except the northern part. It often occurs adjacent to the rivers or streams; the less well-drained Eel soils occupy the more removed positions. All areas are subject to flooding, especially in spring. A large part of the rainfall is removed internally. The native vegetation included a deciduous forest in which elm and sycamore were prominent species.

Profile description in cultivated areas:

- 0 to 7 inches, grayish-brown to brown friable medium-granular silt loam; organic content variable but usually relatively low; neutral to slightly alkaline.
- 7 to 30 inches, yellowish-brown to brown friable granular heavy silt loam to silty clay loam that has a platy structure; thin layers of fine sandy material present; neutral to slightly alkaline.
- 30 inches +, yellowish-brown to brown calcareous silty clay loam to sand; texture extremely variable and depositional layers easily recognized.

The variations from the above description are in the texture and thickness of the various horizons and the organic-matter content of the surface horizons. Where Genesee silt loam grades into Eel soils, the subsoil below a depth of 30 inches may be slightly mottled gray and yellow.

Use and management.—Most of this soil is at present under cultivation. It occurs in relatively large areas in the valleys of the Wabash and the Eel Rivers and often may make up an entire field unit. The rotation in common use included 2 years of corn, wheat, sweetclover or alfalfa, and soybeans. This rotation is varied, however, to include oats and other field crops and vegetables, but principally sweet corn. Areas of this soil close to Logansport are often used more extensively for vegetables than those in other parts of the county. Where Genesee silt loam comprises a large part or all of the field unit, the rotation may be corn for 2 years and soybeans. It is well adapted to corn. A common practice is to use fertilizer with corn. Wheat is well adapted, but there is always a danger of damage from floodwater, especially early in spring. Oats are grown to a limited extent and usually take the place of wheat in the rotation.

Excellent stands of both clover and alfalfa can be obtained without the use of lime, although there is considerable loss to the crop from floodwater. Sweet corn is grown rather extensively in the areas near Logansport in some years. Tomatoes and other vegetables are well adapted, but the acreage used for these crops is variable. Excellent stands of bluegrass pasture are obtained, and a small proportion is in this use. Only a small part remains in timber. These areas are principally adjacent to the streams.

A summary of suitable management practices is given under management group 11 of table 10.

Gravel pits.—This separation includes areas where gravel has been removed for industrial and agricultural use. The pits vary considerably in size and are usually in areas that were formerly Fox or Bellefontaine soils. The gravel has been removed below the permanent water table in some areas, and ponds form a part of the pits.

Griffin fine sandy loam (0 to 2 percent slopes) (Gd).—This is a moderately well-drained to imperfectly drained soil developed on sandy alluvium that was carried from regions of light-textured calcareous Wisconsin drift. It is mapped in the first bottoms of Crooked Creek and other small drainageways in the northwestern part of the county. The native vegetation included chiefly sycamore, elm, and maple.

Profile description in cultivated areas:

- 0 to 7 inches, brownish-gray to yellowish-brown very friable fine sandy loam; organic-matter content variable but usually low; slightly acid to neutral.
- 7 inches +, gray fine sand to sand, highly stained, mottled, and blotched with brown and yellow, that continues to depths of 4 feet or more; slightly acid to neutral.

In undisturbed areas the yellow and brown mottling occurs on the surface or within 2 or 3 inches of the surface in many areas.

Use and management.—Practically all areas of Griffin fine sandy loam are either in forest or in permanent bluegrass pasture, and all are subject to periodic flooding. Since this soil occurs along the small drainageways, the areas are never large, and they are often cut by streams that flow from the upland into the main stream. As a result fields in many instances are irregular in size and shape and many are too small to be cultivated. This soil is better adapted to permanent pasture than to cultivated crops. The quality of the pasture varies, but it may be improved by proper weed control.

Suitable crop rotations and other management suggestions are given under management group 12 in table 10.

Hartman silt loam (0 to 2 percent slopes) (Hb).—This well-drained light-colored soil developed on poorly assorted gravel, sand, cobblestones, and silt that are highly calcareous. It occurs on high bottom or low terrace positions, intermediate between the higher terraces on which Fox soils are developed and the alluvial floodplains. It is mapped principally in the valleys of the Wabash and the Eel Rivers and of Pipe Creek. The relief is nearly level, and surface drainage is slow; thus erosion is not a problem. Movement of moisture through the soil is moderate to rapid. Native vegetation included a deciduous forest.

Profile description in cultivated areas:

- 0 to 7 inches, grayish-brown or brown friable silt loam relatively low in organic-matter content; the firm but not hard medium crumb aggregates are well-developed; a few rounded pebbles and an occasional stone are on the surface and in the horizon; neutral to slightly acid.
- 7 to 24 inches, brown gravelly loam to gravelly clay loam that contains numerous rounded stones, some 12 inches or more in diameter; slightly plastic when moist and hard when dry; content of gravel and stones variable but usually large; neutral to slightly acid.
- 24 inches +, gray and yellow somewhat stratified but usually not well-assorted gravel, sand, and rounded stones and a small quantity of silt; calcareous.

Variations are in the color and thickness of the horizons, in the quantity of gravel and stones on the surface and through the profile, and in the number of stones in the underlying material.

Use and management.—The rotation in general use includes corn, wheat, soybeans, and sweetclover, and an occasional crop of alfalfa and other hay crops and some vegetables. Wheat usually follows corn.

Sweetclover follows wheat in the rotation and often is used as a green manure crop. It is sown with wheat in spring and plowed under the following spring and the land planted to corn. Alfalfa is well adapted, and very little if any lime is needed for the success of either alfalfa or sweetclover. A few areas are so stony at depths of 3 to 8 inches that they are difficult to cultivate. These areas are largely in permanent bluegrass pasture. A few areas remain in forest.

Suitable management practices are given under management subgroup 2A in table 10.

Hartman loam (0 to 2 percent slopes) (HA).—This is a well-drained light-colored soil developed on poorly assorted gravel, sand, cobblestones, and some silt. It occupies a position intermediate between the higher terraces of Fox soils and the alluvial floodplains of Genesee and Eel soils. The areas are not subject to overflow except in periods of extremely high water. The soil occurs on nearly level relief, and natural drainage is good. The movement of moisture through the profile is moderate to somewhat rapid. It is mapped principally in the valley of the Eel River in small irregular-shaped areas. Natural vegetation included a deciduous forest.

Hartman loam differs from Hartman silt loam in profile characteristics chiefly in having a loam surface texture to depths of 6 to 8 inches and a somewhat lighter textured subsoil. The content of rounded glacial stones or boulders on the surface and through the profile is variable but usually high—so high that in some areas the soil is not suited to cultivation. Included with this soil are a few tracts in the eastern part of the county adjacent to the Eel River that have a fine sandy loam surface soil.

Use and management.—Corn, wheat, soybeans, alfalfa, and sweetclover are the principal crops. Alfalfa and sweetclover are well-adapted, and excellent stands are obtained without the use of lime. Sweetclover is used principally as a green-manure crop. A considerable proportion of this soil is in permanent bluegrass pasture of excellent quality. It is estimated that 25 percent of the area remains in forest. Crops are occasionally damaged by floodwaters, but severe damage occurs only about once in 10 years.

Suitable crop rotations and other suggested management practices are given under management subgroup 2A in table 10.

Homer fine sandy loam (0 to 2 percent slopes) (Hc).—This is a light-colored soil developed on highly calcareous glaciofluvial gravel and sand of Wisconsin Age. It is the imperfectly drained member of the soil catena that also includes the well to excessively drained Fox, moderately well drained Bronson, very poorly drained dark-colored Westland, and very poorly drained very dark-colored Abington soils. It occurs on nearly level relief in close association with Bronson, Nyona, and Lear soils, principally in Jefferson and Boone Townships. Nearly all the areas have been artificially drained to permit cultivation. Drainage is easily accomplished, where outlets are available, by lowering the general water table in the underlying gravel and sand. Movement of water and air through the profile is moderate to rapid; in fact some areas are somewhat droughty in summer. Native vegetation included principally a beech-maple association.

Profile description in cultivated areas:

- 0 to 7 inches, brownish-gray to light brownish-gray friable fine sandy loam, low in organic-matter content; the number of small rounded stones and gravel on the surface and in the horizon is variable but generally small; medium to slightly acid.
- 7 to 15 inches, mottled gray, yellow, and brown fine sandy loam to sandy loam that contains enough finer textured material to be slightly compact in place; breaks easily into rather loose, single-grained material; medium acid.
- 15 to 36 inches, mottled gray, yellow, and brown sandy or gravelly and somewhat waxy loam to clay loam; breaks into medium to large angular pieces that when moist are easily broken down into small subangular blocky aggregates; a few rounded rock fragments and an occasional large rounded boulder are present; slightly plastic when moist and hard when dry; upper part of the horizon medium acid; a gradual change to slightly acid or neutral with depth.
- 36 inches +, gray and light-yellow loose stratified calcareous gravel and sand.

Homer fine sandy loam varies from the above description in color and thickness of the various horizons; in depth to mottling (6 to 14 inches); and in depth to calcareous gravel and sand (30 to 45 inches or more). Included are a few small areas in Jefferson and Boone Townships that have a dark brownish-gray surface soil to depths of 6 or 8 inches. Here the organic-matter content is considerably higher than normal.

Use and management.—Homer fine sandy loam occurs in close association with Bronson, Nyona, and other soils in areas of irregular size and shape. Management practices and rotations are therefore influenced considerably by associated soils. The rotation in general use includes corn, wheat or oats, soybeans, and hay crops, including alfalfa grown alone or a mixture of alfalfa, clover, alsike, and timothy. This rotation may be altered to include special field and hay crops and an occasional vegetable crop. Except for the included dark-colored areas, the surface soil is low in organic-matter content; and any management program should include the use of all available organic matter, including the turning under of green manure crops. Crops respond well to fertilizer applications and lime.

Alfalfa is well adapted, provided sufficient lime is applied and drainage is adequate. Only a small part of this soil is in permanent bluegrass pasture, and a much smaller part remains in forest.

Suitable management practices are given under management subgroup 5B in table 10.

Homer silt loam (0 to 2 percent slopes) (Hd).—This is a light-colored soil developed on highly calcareous glaciofluvial gravel and sand of Wisconsin age. It is an imperfectly drained member of the soil catena that also includes the well to somewhat excessively drained Fox, moderately well drained Bronson, very poorly drained dark-colored Westland, and the very poorly drained very dark-colored Abington soils. It occurs on nearly level relief, and thus erosion is not a problem in management. Practically all areas are artificially drained to permit cultivation. The soil occurs principally on the terraces adjacent to the Wabash and the El Rivers in association with Fox, Westland, and Abington soils. Native vegetation included a beech-maple association.

Profile description in cultivated areas:

- 0 to 7 inches, light brownish-gray friable silt loam, low in organic-matter content; fine crumb structure aggregates that pulverize rather easily into smooth material; slightly to medium acid.

- 7 to 17 inches, mottled gray, yellow, and brown heavy silt loam to silty clay loam; breaks into fine subangular blocky aggregates; numerous small, firm, dark-brown iron concretions in some areas; strongly acid.
- 17 to 40 inches, mottled gray, yellow, and brown heavy clay loam to silty clay loam; breaks into medium to coarse subangular blocky aggregates that are plastic when moist, sticky when wet, and hard when dry; somewhat impervious to moisture movements and to roots; lower part of the horizon somewhat lighter textured and contains considerable quantities of gravel and small rounded stones; reaction of the upper part of the horizon is strongly acid; a gradual change to slightly acid with depth.
- 40 inches +, gray and light-yellow highly calcareous stratified gravel and some sand.

Variations are in the color, texture, and thickness of the various horizons; in depth to mottling (6 to 14 inches); and the depth to calcareous gravel (30 to 46 or more inches). The content of gravel in the subsoil also varies but is usually somewhat less than in the Fox or Bronson soils.

Use and management.—Homer silt loam occurs in close association with Fox, Westland, Abington, and other soils, and the field unit is seldom entirely of Homer soils; thus management practices and crop rotations are influenced by the associated soils. It is necessary to drain the soil artificially for crop production. A few areas are in need of more adequate drainage. This soil is somewhat cold in spring, and the planting of corn, oats, and other crops is often retarded during seasons of abnormally high moisture conditions.

The rotation in general use includes corn, wheat or oats, soybeans, alfalfa, and mixed hay (including alfalfa, clover, alsike, and timothy) and minor hay and field crops and some vegetables. The supply of organic matter in the surface soil is usually low, and it is necessary to plow under all available organic matter for the success of corn as well as other crops. Corn yields are dependent to a large extent upon the adequacy of drainage, seasonal conditions, and fertility level. Soybeans have a prominent place in the rotation and usually follow corn or small grains. Wheat follows corn or soybeans. Wheat is occasionally damaged in winter and spring by excessive moisture and by heaving. Oats occasionally replace wheat in rotation.

It is necessary to apply sufficient lime to this soil for the success of alfalfa and clover. Hay crops are occasionally damaged by excessive moisture and by heaving. A small part of this soil is in permanent bluegrass pasture of fair quality. These pastures could be improved materially by the use of lime and phosphate fertilizer and by weed control. Only a few areas are in timber.

Suitable rotations and other crop management practices are given under management subgroup 5A in table 10.

Kokomo loam (0 to 2 percent slopes) (Cc).—This soil was developed on highly calcareous Wisconsin glacial till. It is a very poorly drained, very dark-colored member of the soil catena that also includes the well-drained Miami, the imperfectly drained Crosby and Conover, the poorly drained Bethel, and the very poorly drained dark-colored Brookston soils. It is mapped in the deeper depressions and depressed flats in close association with Brookston loam in the areas north of the Wabash River. Natural drainage conditions are very poor, but the greater part has been artificially drained to permit cultivation. The native vegetation included marsh grasses and water-loving trees.

Profile description in cultivated areas:

- 0 to 7 inches, very dark-gray to nearly black friable medium granular loam, high in organic matter; neutral.
- 7 to 18 inches, very dark-gray heavy loam to clay loam that breaks into large blocky aggregates; content of gravel variable, and an occasional large boulder present; slightly plastic when moist and hard when dry; neutral.
- 18 to 30 inches, light-gray to gray (with faint light-yellow or brown mottlings in the lower part) clay loam to silty clay loam; breaks into coarse blocky aggregates that are plastic when moist, somewhat sticky when wet, and hard when dry; content of grit and rock fragments varies but usually considerable; neutral.
- 30 to 50 inches, mottled gray, yellow, and brown clay loam that breaks into large angular pieces; plastic when moist and very hard when dry; rock fragments numerous and an occasional large boulder present; neutral.
- 50 inches +, mottled gray, yellow, and brown loam highly calcareous glacial till, consisting of unassorted silt, clay, sand, and rock fragments.

The variations in the profile are in the content of organic matter in the surface and upper subsoil horizons, and in the color, texture, and thickness of the various horizons. Where Kokomo loam grades into Brookston loam the color of the surface soil is somewhat lighter, and the combined thickness of the first two layers is somewhat less.

Use and management.—The common rotation includes corn, soybeans, wheat or oats, and hay crops, including a mixture of clover, alfalfa, and timothy, or clover or alfalfa grown alone. This soil is well adapted to corn and soybeans where artificial drainage is adequate, and yields are about equal to those obtained on Kokomo silty clay loam. The average yields over a 10-year period are somewhat less than those on the associated Brookston loam because of the occasional loss or reduction in yields caused by drowning out or the inability to seed the areas. Small grains are somewhat better adapted to this soil than to Kokomo silty clay loam, although there is rather frequent damage from drowning out, heaving, and lodging. The newer stiff-stemmed oat varieties are less susceptible to lodging. Hay crops, including clover and alfalfa, are well adapted where drainage is adequate, and it is not necessary to apply lime for good stands of alfalfa and clover. A few areas are inadequately drained for crops and are in bluegrass pasture or timber.

Suitable rotations and other management practices are given under management group 7 in table 10.

Kokomo silty clay loam (0 to 2 percent slopes) (Cd).—This soil was developed on highly calcareous loam till of Wisconsin glacial age. It is a very poorly drained very dark-colored member of the soil catena that also includes the well-drained Miami, imperfectly drained Crosby and Conover, poorly drained Bethel, and very poorly drained dark-colored Brookston soils. It is also mapped as a very poorly drained, very dark-colored member of the catena that includes the well-drained Russell, imperfectly drained Fincastle, poorly drained Delmar, and very poorly drained dark-colored Brookston soils.

It occupies the deeper depressional areas of the uplands, closely associated with Brookston soils and is mapped in small scattered areas, principally south of the Wabash River. The greater part of Kokomo silty clay loam has been artificially drained to permit cropping. The native vegetation consisted of marsh grasses and water-loving trees.

Profile characteristics in cultivated areas:

- 0 to 7 inches, very dark-gray to nearly black silty clay loam, relatively high in organic matter; neutral.
- 7 to 18 inches, dark-gray to very dark-gray gritty silty clay loam to clay loam, relatively high in organic matter; an occasional large boulder present and the content of sand and fine gravel variable; breaks into angular pieces that become hard when dry; neutral.
- 18 to 28 inches, light-gray to gray (with faint light-yellow or brown mottlings in the lower part of the horizon) heavy plastic clay loam; usually contains much grit and rock fragments; neutral.
- 28 to 50 inches, mottled gray, yellow, and brown clay loam that breaks into large angular pieces; plastic when moist, very hard when dry; neutral.
- 50 inches +, mottled gray, yellow, and brown loam calcareous glacial till consisting of unassorted silt, clay, sand, and rock fragments.

Kokomo silty clay loam varies from the above profile characteristics in the texture and thickness of the various horizons and in the depth to calcareous till. A few areas in the deeper depressions, especially in association with the larger areas of Brookston silty clay loam, have silty clay surface soils. Some undisturbed areas may have a few inches of silty muck on the surface.

Use and management.—This soil occurs in close association with Brookston silty clay loams; the crop rotations and management practices are therefore very similar to those on the Brookston soil. The rotation includes corn, soybeans, wheat or oats, and hay crops. Kokomo silty clay loam is well adapted to corn and soybeans, provided sufficient drainage is installed. In seasons of abnormally high rainfall, these and other crops are frequently drowned out or not planted. Small grains are not well adapted because of the high organic-matter and nitrogen content and the danger from drowning out and heaving. There is considerable damage to small grains from lodging of the grain, although use of newer stiff-stemmed oat varieties may reduce this. Clover and alfalfa are well adapted, and it is not necessary to lime the areas to secure good stands. Where drainage is insufficient, drowning out causes considerable loss of these crops. A few small areas have not been drained and at present are in small buttonwood trees.

Suitable management practices are given under management group 7 in table 10.

Lear loam (0 to 2 percent slopes) (LA).—This is a very poorly drained very dark-colored soil developed on highly calcareous poorly assorted gravel and sand containing minor quantities of silt and clay. It occurs in the northwestern part of the county in close association with Nyona loam and Bronson fine sandy loam on the prairie border areas of the outwash plain. Most of the areas have been artificially drained to permit cropping, although a few areas could be improved by more adequate drainage. Most of the rainfall is removed internally, but in seasons of high rainfall there may be some ponding where drainage is inadequate. Native vegetation included water-tolerant trees and marsh grasses.

Profile description in cultivated areas:

- 0 to 7 inches, very dark brownish-gray to nearly black friable loam, high in organic-matter content; a few rounded glacial pebbles on the surface and in the horizon; slightly acid to neutral.
- 7 to 18 inches, very dark gray friable heavy loam to clay loam; high in organic content; neutral to mildly alkaline.

18 to 36 inches, gray sandy loam to clay loam that breaks into pieces irregular in size and shape; friable to slightly plastic when moist and slightly hard when dry; considerable gravel and rounded glacial pebbles; neutral to mildly alkaline.

36 inches +, gray slightly mottled with light-yellow highly calcareous gravel and sand and minor quantities of silt and clay; not well-assorted.

Variations are in the color, organic-matter content, and thickness of the first two horizons and the depth to calcareous material, which is 32 to 40 inches or more.

Use and management.—The crops grown on this soil are determined somewhat by the extent of the associated Nyona loam and Bronson fine sandy loam. They include corn, soybeans, wheat, oats, and hay crops and small quantities of vegetables and special hay and field crops. Corn and soybeans are well adapted if drainage is adequate. There is some loss, however, to these crops from drowning out. Small grains are not so well adapted to this soil as to the better drained ones, but they are occasionally used in the rotation, especially where the field unit is largely of other soils. Wheat is occasionally drowned out in winter and early in spring, and there is some loss from lodging of the grain both for oats and wheat. Use of the newer stiff-stemmed varieties of oats may reduce this loss.

Clover and alfalfa may be grown without the use of lime, although losses occur from drowning out. A few areas are in permanent bluegrass pasture of good to excellent quality. Areas of this soil having inadequate drainage often remain idle in seasons of abnormally high moisture conditions.

Suitable management practices are given in management group 8 in table 10.

Limestone rockland (1 to 30 percent slopes) (Lb).—This separation includes benchlike areas or "rock cut" terraces along the Wabash River where limestone bedrock outcrops. Only an inch or 2 of loamy or silty material is on the surface. Numerous large partially rounded glacial boulders and limestone slabs are on the surface. The relief is nearly level to steep. It supports a growth of shrubs and trees and in a few places fair stands of Kentucky bluegrass. This separation is essentially nonagricultural land.

Made land (M).—This soil includes areas that have been disturbed either by additions on the former surface or by a removal of the surface. These areas are largely in or adjacent to Logansport. They are used as building sites and railroad yards and have little agricultural use.

Maumee fine sandy loam (0 to 2 percent slopes) (Ma).—This is a very poorly drained, very dark-colored soil developed on calcareous sands of Wisconsin age. It occurs in deep depressions and depressed flats in the outwash plain areas of the northwestern part of the county. The associated soils include Maumee loam and Berrien, Dillon, and Newton soils. A considerable part has been artificially drained to permit cropping. Most of the rainfall is removed internally because of the nearly level relief and the ease with which water passes through the soil. The native vegetation included principally marsh grasses and water-tolerant trees.

Profile description in cultivated areas:

- 0 to 7 inches, very dark-gray to nearly black very friable fine sandy loam high in organic content (the surface 2 to 3 inches in undisturbed areas often nearly black loamy muck).
- 7 to 18 inches, very dark-gray loose fine sandy loam to fine sand; a somewhat heavier textured and slightly coherent layer 2 to 4 inches thick occurs in this horizon in some areas, although variable in occurrence and not uniform in distribution; slightly acid to neutral.
- 18 inches +, gray loose fine sand or sand that extends to depths of 10 feet or more; below 3 feet the color changes gradually to mottled gray, yellow, and brown in some areas; neutral to slightly alkaline in the upper part of the horizon, gradually changing to calcareous at depths of 3 to 4 feet.

The variations are in the color, organic-matter content, and thickness of the first two horizons and in the color of the deeper substrata. Included are a few areas that have medium acid surface soils.

Use and management.—A large percentage of this soil is at present in forest or in permanent bluegrass pasture, and the greater part of these areas do not have enough drainage to permit cultivation. The principal crops on the drained areas include field corn, sweet corn, soybeans, wheat, and hay, including principally timothy. This soil is very well adapted to corn and soybeans, although the light texture and rapid permeability tend to make it somewhat droughty in some areas, especially those that are somewhat overdrained. It is not so well adapted to small grains as to corn and soybeans. Wheat usually follows corn in the rotation.

Good stands of alfalfa are obtained without the use of lime, but there is some danger to the crop because of drowning out. Excellent stands of bluegrass pasture may be obtained, and a considerable part is used for such pasture.

Suitable management practices are given under management group 8 in table 10.

Maumee loam (0 to 2 percent slopes) (M_B).—This is a very poorly drained, very dark-colored soil developed on calcareous sands of Wisconsin age. It occurs in depressions and broad depressed flats in the outwash plain area in the northwestern part of the county. The associated soils are principally Newton, Dillon, Berrien, and Plainfield. Most areas have been artificially drained to permit cropping. Drainage is easily established, where outlets are available, by lowering the general water table in the area. Most of the rainfall is removed internally; after the water table has been lowered the water goes through the soil rather rapidly. The native vegetation included principally marsh grasses and water-loving trees.

Profile description in cultivated areas:

- 0 to 7 inches, very dark-gray to nearly black friable loam high in organic-matter content (a thin layer of loamy muck on the surface in many of the undisturbed areas); slightly acid to neutral.
- 7 to 18 inches, very dark-gray friable nearly loose loam to fine sandy loam, relatively high in organic-matter content; a 2- to 4-inch layer of heavier textured material in some areas; this layer not uniform in occurrence; slightly acid to neutral.
- 18 inches +, gray loose fine sand to sand that gradually changes to mottled gray, yellow, and brown below a depth of 3 feet; extends to depths of 10 feet or more; reaction in the upper part of the horizon neutral, gradually changing to calcareous at depths of 3 to 4 feet.

The variations are in the color, organic-matter content, and thickness of the first two horizons and in the color of the third horizon.

Use and management.—The principal crops on the drained areas are field corn, sweet corn, soybeans, wheat or oats, and hay crops, including principally timothy and lesser quantities of clover and alsike. The content of organic matter and nitrogen is relatively high, but that of phosphate and potash is low. Additions of lime are not necessary for legumes except on a few areas. Corn is grown occasionally for 2 or more consecutive years and is followed by wheat or soybeans. Sweet corn occasionally takes the place of field corn in the rotation. In some years small grains are damaged by a high water table. Lodging often occurs but stiff-stemmed oat varieties may reduce this hazard.

Some alfalfa is grown, although considerable damage results from drowning out in winter and early in spring. Excellent stands of bluegrass pasture are obtained on this soil, although there is some injury from the droughtiness on overdrained areas. The areas of this soil that are undrained or not adequately drained for crops are in forest or permanent pasture.

Suitable management practices are given under management group 8 in table 10.

Metea fine sandy loam (2 to 6 percent slopes) (Mc).—This is a somewhat excessively drained light-colored soil developed on light-textured highly calcareous Wisconsin glacial till. It is mapped in small isolated areas in the northern part of the county in association with Miami loam and fine sandy loam and Coloma soils. The relief is undulating to gently rolling, and surface drainage is good to somewhat excessive. This soil occasionally occurs as low knolls or in slightly elevated positions above the associated Miami soils. Native vegetation included a deciduous forest; oak and hickory were the predominant species.

Profile description in cultivated areas:

- 0 to 7 inches, grayish-brown to light yellowish-brown very friable fine sandy loam, low in organic-matter content; a few pebbles on the surface and in the profile; medium to strongly acid.
- 7 to 24 inches, light yellowish-brown to brownish-yellow very friable fine sandy loam containing an occasional glacial rock; medium to strongly acid.
- 24 to 45 inches, brownish-yellow clay loam to loam containing various quantities of small angular rock fragments and an occasional large boulder; breaks into medium to coarse subangular blocky aggregates; friable when moist and slightly hard when dry; medium acid in the upper part of the horizon, gradually changing with depth to slightly acid.
- 45 inches +, grayish-yellow to pale-yellow highly calcareous loam glacial till consisting of a mixture of silt, clay, sand, and rock fragments.

Variations are in the color and thickness of the first two layers, texture of the third layer, and the depth to calcareous till. The thickness of the sandy material is 20 to 30 inches, and the depth to calcareous till is 40 to 55 inches. Where Metea fine sandy loam grades into Coloma soils, the texture of the surface soil is somewhat lighter, and the depth of the sandy material is greater than normal. Where it grades into Miami soils, the thickness of the sandy horizons is less than normal.

Use and management.—The greater part of Metea fine sandy loam is under cultivation to the common crops of the region. A field unit often includes Metea and several associated soils, and the rotation is necessarily similar to that on the associated soils. Corn, soybeans, wheat, and hay, including alfalfa grown alone or a mixture of alfalfa,

clover, alsike, and timothy, are the principal crops. Oats sometimes replace wheat in the rotation, and special field and hay crops are grown occasionally. The organic-matter content is low, and this soil is droughty in periods of low moisture conditions. Any management program should include a rotation in which the proportion of small grains and hay crops is high, and all available organic matter should be plowed under.

Corn usually follows hay crops in the rotation. Yields are materially reduced when low moisture conditions prevail, especially in late summer and early fall. A few farmers topdress wheat with barnyard manure in winter, although this is not a general practice. Oats occasionally take the place of wheat in the rotation but are not so well adapted. The somewhat droughty conditions during the growing season of oats reduce the yields materially.

It is necessary to apply lime to this soil for the success of clover and alfalfa. Alfalfa is probably better adapted than clover, as it will withstand the somewhat droughty condition that exists in summer and fall. A few areas are in permanent bluegrass pasture of fair to good quality. Pastures can be improved by the use of sufficient lime and phosphate fertilizer and by weed control. Only a relatively small part of this soil remains in forest.

Suitable crop rotations are given under management subgroup 2C in table 10.

Miami fine sandy loam (2 to 6 percent slopes) (Md).—This is a light-colored soil developed on light-textured highly calcareous Wisconsin glacial till. It is the well-drained member of the soil catena that also includes the imperfectly drained Crosby and Conover, the poorly drained Bethel, the very poorly drained dark-colored Brookston, and the very poorly drained very dark-colored Kokomo soils.

Miami fine sandy loam is extensively mapped in the upland areas of the county north of the Wabash and the Eel Rivers. It is closely associated with Metea and Coloma soils, Crosby fine sandy loam, Conover fine sandy loam, and Brookston loam. The larger and more extensive areas occur in central and eastern Boone Township, Harrison, Bethlehem, and Adams Townships, the northern parts of Noble and Clay Townships, and to a lesser extent in the southern, central, and northeastern parts of Jefferson Township. It occurs on slopes of 2 to 15 percent, but most areas are on slopes of 2 to 6 percent. Surface runoff is medium on the milder slopes and rapid on the steeper slopes. The rate of movement of water downward through the soil profile is moderate to rapid. Erosion control, especially on the more sloping areas, is not such a problem as on comparable slopes of Miami loam and silt loam. Native vegetation consisted chiefly of white oak, sugar maple, ash, elm, walnut, and hickory.

Profile characteristics in cultivated areas:

- 0 to 8 inches, grayish-brown to light yellowish-brown fine sandy loam, relatively low in organic-matter content; medium acid.
- 8 to 12 inches, yellowish-brown friable loam to silt loam that breaks into medium to coarse granules; medium acid.
- 12 to 32 inches, yellowish-brown to brownish-yellow heavy silt loam to clay loam; breaks into medium-sized subangular blocky aggregates that are easily crushed when moist but are slightly hard when dry; rock fragments and rounded gravel in various quantities throughout and an occasional large boulder; medium acid.

32 to 36 inches, yellowish-brown to dark yellowish-brown silt loam to clay loam; more friable than the above horizon and the subangular blocky aggregates less well developed; slightly acid to neutral.

36 inches +, gray and yellow sandy loam to loam highly calcareous glacial till composed of unassorted silt, clay, sand, and rock fragments.

Variations in the profile characteristics of Miami fine sandy loam are in the thickness, texture, and structure of the various horizons and in the depth to calcareous till. In some areas where this soil occurs adjacent to areas mapped as Miami loam, the boundaries between the two soils are arbitrarily drawn.

Use and management.—The rotation and management practices on Miami fine sandy loam are about the same as those on Miami loam. The rotation includes corn, wheat or oats, soybeans, and hay crops. Rye occasionally takes the place of wheat or oats, and an occasional special field or vegetable crop may be grown. The rotation is occasionally altered because of crop failures, economic conditions, and the individual farm requirements for feed.

Corn usually follows hay crops in the rotation, or it may be grown after soybeans. Good management practices are essential for good corn yields. This soil is not so well adapted to corn as are the heavier textured Miami loam and silt loams. Organic matter does not appear to be as stable as in the heavier textured soils.

While a comparatively large acreage of Miami fine sandy loam is planted to oats each year, the soil is not so well adapted to this crop as are the heavier textured types. Oats are occasionally damaged by hot, dry periods in early summer, and yields are materially reduced. Soybeans are occupying an increasingly important place in the rotation and are grown both for seed and for hay. The majority of the increase in acreage, however, has been for seed.

Hay crops include a mixture of alfalfa, clover, timothy, and alsike, and in some instances brome grass, or alfalfa or clover grown alone. It is necessary to apply sufficient lime to raise the pH to 6.0 or higher for the success of alfalfa and clover. Clover alone is grown less extensively at present than in former years and has been replaced largely by mixed hay or alfalfa. A considerable portion of the more rolling and steeper areas is in permanent bluegrass pasture or in forest. The bluegrass pastures can be improved materially by the use of sufficient lime and commercial fertilizer.

Suitable management practices are summarized under management subgroup 2C in table 10.

Miami loam (2 to 6 percent slopes) (ME).—This light-colored soil was developed on highly calcareous Wisconsin glacial till. It is a well-drained member of the soil catena that also includes the imperfectly drained Crosby and Conover, the poorly drained Bethel, the very poorly drained dark-colored Brookston, and the very poorly drained very dark-colored Kokomo soils.

Miami loam occurs on undulating to gently sloping areas. Slopes range from 2 to 15 percent, but are mostly 2 to 6 percent. This soil is mapped in the region of Wisconsin glaciation, and is associated with Metea and Coloma soils and with Crosby loam and Brookston silty clay loam. The larger areas occur in the east-central part of Adams Township, central Clay Township, and central Noble Township. Surface runoff is medium to rapid, and the rate of movement of water through the soil is moderate. Surface runoff is high on the more

sloping areas, and unless a cover crop is maintained, erosion becomes a problem. The original vegetation consisted chiefly of sugar maple, beech, walnut, white oak, hickory, ash, and elm.

Profile characteristics in cultivated areas:

- 0 to 8 inches, grayish-brown to light yellowish-brown friable, medium granular loam; organic-matter content relatively low; medium acid.
- 8 to 11 inches, light yellowish-brown to yellowish-brown friable, heavy loam to light silt loam; composed of medium-sized granular aggregates that are easily crushed when moist; medium acid.
- 11 to 30 inches, yellowish-brown to brownish-yellow heavy silt loam to light silty clay loam; upper part of horizon breaks into subangular blocky aggregates from $\frac{1}{8}$ to $\frac{1}{4}$ inch in diameter, and the lower part into subangular blocky aggregates from $\frac{1}{2}$ to $1\frac{1}{2}$ inches in diameter; aggregates may be easily broken down into coarse granules when moist but are hard when dry; permeable to moisture movements and plant roots; medium acid.
- 30 to 36 inches, yellowish-brown or dark yellowish-brown silty clay loam that is slightly more friable than the above horizon; permeable to moisture movements and to plant roots; slightly acid to neutral.
- 36 inches +, gray and yellow loam highly calcareous glacial till composed of unsorted silt, clay, sand, and rock fragments.

Miami loam varies in texture, structure, and thickness of the various horizons. Included are numerous small areas on which a part of the surface soil has been removed by accelerated erosion. Here the surface soil is heavier textured and contains less organic matter, and tilth conditions are not so good as on the uneroded areas. Where Miami loam grades into either Miami fine sandy loam or Miami silt loam, the boundaries may be arbitrarily drawn, and areas mapped as Miami loam may include small areas of these soils.

Use and management.—The crop rotation and management practices on Miami loam are similar to those on Miami silt loam. The rotation includes corn, wheat or oats, soybeans, and hay crops. The hay crops commonly grown include a mixture of alfalfa, clover, timothy, and alsike, and some brome grass, or clover or alfalfa grown alone. This rotation may be varied to include an occasional special vegetable crop, as potatoes or sweet corn, and field crops, as rye and other minor field crops.

Wheat usually follows corn or soybeans in the rotation. Wheat is well adapted because of the good drainage conditions and the favorable relief of most areas. Oats are probably not so well adapted to Miami loam as to Miami silt loam, but they often replace wheat in the rotation system. The yields of oats are determined largely by the weather conditions during the growing season, especially early in summer. Since oats usually follows corn or soybeans in rotation the soil is left without a protective covering during the preceding winter. This tends to discourage the growing of oats on the more sloping areas.

Soybeans are increasing in importance on this soil. They are grown both for seed and for hay, but the large increase in recent years has been largely for seed. They usually follow corn in the rotation.

In the spring, hay crops usually are sown in wheat or rye or with oats. Enough lime to raise the pH to 6.0 or higher is necessary for the success of alfalfa and clover. There has been a trend in recent years toward the increased use of a mixed hay that includes alfalfa, clover, timothy, alsike, and some brome grass, rather than clover alone. The acreage of alfalfa grown alone has also increased in recent years because of the more general use of lime.

The steeper areas of this soil are largely in forest or in permanent bluegrass pasture. Good pastures can be maintained with the use of proper quantities of lime and commercial fertilizer and a good grazing program.

Suitable crop rotations and other management practices are given under management subgroup 1A in table 10.

Miami silt loam (2 to 6 percent slopes) (Mf).—This is a light-colored soil developed on highly calcareous Wisconsin glacial till. It is a well-drained member of the soil catena that also includes the imperfectly drained Crosby and Conover, the poorly drained Bethel, the very poorly drained dark-colored Brookston, and the very poorly drained very dark-colored Kokomo soils.

Miami silt loam occurs on undulating to gently sloping relief. The gradient ranges from 2 to 15 percent but in most areas is from 2 to 6 percent. The soil occurs in the upland areas in Miami Township between the Eel and the Wabash Rivers; in the southern part of Adams Township; the southeastern part of Clay Township, adjacent to the glaciofluvial outwash plains and terraces; and south of the Wabash River. It is associated principally with Crosby silt loam and Brookston silty clay loam, although smaller areas of Bellefontaine and Kokomo soils are also associated.

Surface runoff is medium to rapid, and the rate of movement of water through the soil profile is moderate. Erosion is a problem on areas that occur on the greater gradient, especially where a protective cover crop is absent in winter. The original vegetation consisted chiefly of sugar maple, beech, ash, elm, walnut, hickory, and white oak.

Profile characteristics in cultivated areas:

- 0 to 7 inches, grayish-brown to light yellowish-brown friable granular silt loam; relatively low in organic matter; slightly to medium acid.
- 7 to 10 inches, light yellowish-brown to yellowish-brown friable coarse granular heavy silt loam; lower in organic-matter content than the above horizon; medium acid.
- 10 to 30 inches, yellowish-brown to brownish-yellow silty clay loam; breaks into subangular blocky aggregates that are from $\frac{1}{4}$ to $\frac{3}{4}$ inch in diameter in the upper part of the horizon, and from $\frac{1}{2}$ to $1\frac{1}{2}$ inches in the lower part; aggregates may be easily broken down into coarse granules when moist but are hard when dry; medium acid.
- 30 to 32 inches, yellowish-brown to dark yellowish-brown silty clay loam; slightly more friable than the above horizon but usually neutral to slightly acid.
- 32 inches +, gray and yellow compact loam calcareous glacial till composed of unassorted silt, clay, sand, and rock fragments.

Miami silt loam varies in texture (except in the surface horizon), structure, and thickness of the various horizons. A few areas have abnormally large quantities of sand and gravel in the profile.

Use and management.—The greater part of Miami silt loam has been cleared for cultivation. The principal rotation in use is 1 year of corn, 1 year of wheat or oats, and 1 year of hay crops. In recent years, however, soybeans have been added to the rotation. Special vegetable crops, as potatoes and sweetcorn, and special field crops are grown occasionally.

Corn is probably the principal crop. Excellent corn yields are obtained frequently under the better management practices that include the use of all available manure, sufficient lime and commercial fertilizer, and the control of erosion. The good natural drainage

condition of this soil makes it well suited to corn, although the relatively low content of nitrogen and occasional shortages of moisture in summer may limit the yield. On the more rolling areas corn should be followed by fall-seeded small grain, such as wheat or rye, to prevent erosion during the winter and early in spring.

This is an excellent soil for wheat. Wheat furnishes a protective cover in winter and aids in retarding erosion, especially on the more rolling areas. The soil is not so well adapted to oats as to wheat, but a large acreage of oats is grown each year. Oats are usually seeded in corn stubble, although they are occasionally seeded after vegetable crops and where legume crops have failed.

Hay crops consist of a mixture of red clover, alfalfa, timothy, alsike, and occasionally bromegrass, or alfalfa or clover alone. It is essential for the success of clover and alfalfa that sufficient lime be applied to this soil. Clover and alfalfa, as well as other hay crops, can be seeded late in summer or early in fall or seeded with oats or over-seeded in wheat in spring. A considerable portion of the steeper slopes is in bluegrass pasture or in forest. Good stands of Kentucky and Canadian bluegrasses can be maintained if enough lime and fertilizer are applied.

Suitable crop rotations and other management practices are given under management subgroup 1A in table 10.

Miami silt loam, sloping phase (8 to 20 percent slopes) (M_G).—The profile characteristics of this phase in the wooded areas are similar to those of the normal phase except that the various horizons are somewhat thinner and the depth to calcareous till is somewhat less. Those areas that are under cultivation or in pasture are moderately to severely eroded and have an occasional gully. Here the surface 6 or 8 inches is yellowish-brown heavy silt loam to light silty clay loam, very low in organic-matter content. Tilth conditions on these areas are poorer than on the uneroded areas. Surface runoff is rapid to very rapid.

Included are a few small areas of colluvial material washed from higher areas of Miami silt loam and deposited at the base of the slopes, often in fan-shaped areas. There is no definite profile; it consists of a mixture of silt, clay, and rock fragments.

Use and management.—A large proportion of Miami silt loam, sloping phase, is in forest. Most of the cultivated areas are moderately to severely eroded. Crops are corn, wheat or oats, soybeans, and hay. The sloping areas are usually farmed in conjunction with areas of the normal soil. Crop yields are considerably lower, however, because of the somewhat lower fertility and eroded condition. Moisture relationships are poorer than on the normal soil. The best use of this phase would be a rotation that has a high percentage of hay and pasture crops.

Suitable crop rotations and other management practices needed are summarized under management subgroup 1B in table 10.

Miami silt loam, steep phase (20 to 40 percent slopes) (M_H).—The steep phase of Miami silt loam consists of areas having slopes of more than 20 percent. It occurs principally adjacent to the valleys of the rivers and drainageways of the county. The profile characteristics are similar to those of the normal phase, except that the various horizons are considerably thinner and the depth to calcareous till is 15 to 25 inches. Surface runoff is very rapid.

Use and management.—Practically all of Miami silt loam, steep phase, is in timber at present. A few small areas, however, have been cleared of timber and are under cultivation or in permanent bluegrass pasture. Erosion is severe on these areas, and crop yields are extremely low. This phase is not suited to cultivation under present economic conditions but is better suited to forest or possibly to bluegrass pasture.

Suitable management practices are given under management subgroup 1C of table 10.

Millsdale silty clay loam (0 to 2 percent slopes) (Mκ).—This soil developed on shallow glaciofluvial material and shallow glacial till of Wisconsin age, on limestone bedrock. Most of the acreage is in depressions and broad depressed flats on terraces and benches along the valley of the Wabash River. The relief is nearly level. Natural drainage conditions are very poor. A relatively small proportion of the areas are artificially drained for crops, although most of the areas are at present too wet for the success of such crops as small grains and vegetables. Native vegetation included deciduous forest of maple, ash, oak, hickory, and elm, and marsh grasses.

Profile description in cultivated areas:

- 0 to 7 inches, very dark brownish-gray to nearly black silty clay loam, high in organic-matter content; neutral.
- 7 to 18 inches, very dark-gray plastic heavy silty clay loam to clay; breaks into coarse blocky aggregates that are slightly plastic when moist, sticky when wet, and very hard when dry; neutral.
- 18 to 32 inches, gray or mottled gray and yellow silty clay or clay loam; breaks into large blocky aggregates that are plastic when moist, very sticky when wet, and very hard when dry; a few rounded pebbles and larger stones throughout the horizon and fragmental partially weathered limestone rock in the lower 2 or 3 inches; neutral to mildly alkaline.
- 32 inches +, limestone bedrock.

This soil varies from the above description in the thickness and organic-matter content of the first two layers, the color of the lower subsoil, and the depth to limestone bedrock, which varies from 18 to 36 inches.

Use and management.—When drainage is adequate, this soil is well adapted to corn and soybeans. Where field units are composed of all or a large part of this soil, corn is grown for 2 or more consecutive years. The soil is high in organic-matter content and nitrogen but somewhat deficient in phosphate and potash. Additions of lime are not needed for legumes.

Corn usually follows hay crops or soybeans in the rotation. This soil is not well adapted to small grains because of heaving, lodging of the grain, the high moisture condition of the soil, and the susceptibility of these crops to drowning out in winter and spring. The use of newer stiff-strawed oat varieties may reduce lodging. Alfalfa and clover are fairly well adapted where the soil is properly drained, although these crops are occasionally severely damaged by drowning out and heaving. This soil is well adapted to permanent bluegrass pasture.

Suitable management practices are summarized under management group 7 in table 10.

Milton silt loam (2 to 6 percent slopes) (ML).—This soil developed on thin deposits of calcareous Wisconsin glacial till or glaciofluvial deposits over limestone bedrock. It is the well-drained member of

the soil catena that also includes the imperfectly drained Randolph and the very poorly drained very dark-colored Millsdale soils. Randolph soils do not occur in sufficient extent in this county to be separated on the map. Milton silt loam occurs on high "rock-cut" terraces along the valley of the Wabash River and in a few places on the uplands. It is associated with Miami and Fox soils. The relief is nearly level to gently sloping, and erosion is potentially severe only on the sloping areas. Surface drainage is slow to medium, and internal movement of water is moderate. Native vegetation included maple, oak, hickory, walnut, and other associated species.

Profile description in cultivated areas:

- 0 to 7 inches, grayish-brown to brown friable silt loam, low in organic-matter content; slightly to medium acid.
- 7 to 15 inches, light yellowish-brown to brown friable heavy silt loam to light silty clay loam that breaks into coarse granular or fine subangular blocky aggregates; friable to slightly firm when moist and slightly hard when dry; a few small rounded stones; slightly to strongly acid.
- 15 to 32 inches, yellowish-brown to moderate brown, occasionally with a weak reddish hue, silty clay loam; breaks into medium to coarse subangular blocky aggregates that are firm to slightly sticky when moist and hard when dry; a few small stones and an occasional boulder; slightly to strongly acid.
- 32 to 36 inches, dark-brown slightly plastic heavy silty clay loam to silty clay containing numerous small rounded stone fragments; coarse subangular blocky; plastic when moist and very hard when dry; neutral to slightly alkaline.
- 36 inches +, limestone bedrock; the upper few inches fractured and partially weathered.

The amount of grit, pebbles, and stones in the surface soil and subsoil is variable, and the depth to bedrock is 20 to 40 inches.

Use and management.—The rotation in general use includes corn, wheat, soybeans, and hay crops, including alfalfa grown alone or a mixture of clover, alfalfa, alsike, and timothy. This rotation is varied to include such field crops as oats and an occasional vegetable crop. The content of organic matter and nitrogen is low, but this soil responds well to good management practices. These should include the addition of all available organic matter, the use of lime to correct acidity, and the use of liberal quantities of commercial fertilizer.

Wheat is well adapted and is the principal small grain crop. Alfalfa and other legumes are also well adapted if sufficient lime is applied. Alfalfa is probably the best use for the more sloping areas because of the erosion hazard when these areas are under clean cultivation. The areas where bedrock occurs at the shallower depths are probably better adapted to bluegrass than to cultivated crops. This soil is well adapted to bluegrass, but pasture improvement, including use of sufficient lime and phosphate fertilizer, and weed control are needed to increase the livestock-carrying capacity on many areas. Only a few small areas remain in forest.

Suitable management practices are summarized under management subgroup 1A in table 10.

Newton fine sandy loam (0 to 2 percent slopes) (NA).—This soil was developed on acid sands of Wisconsin age. It is a very poorly drained, dark-colored member of the soil catena that also includes the excessively drained Plainfield, the moderately well drained Berrien, the imperfectly drained Morocco, and the very poorly drained, very dark-colored Dillon soils. Morocco soils are not extensive enough in this

county to be mapped separately. Newton fine sandy loam occurs in shallow depressions and broad depressed flats in the northwestern part of the county, closely associated with Plainfield, Berrien, and Dillon soils, and in some instances with Maumee soils. A part of the areas have been artificially drained to permit cropping. Most of the rainfall is removed internally, as moisture movements through the soil are rapid. In fact some drained areas are droughty in summer and early fall. The native vegetation included water-loving trees, sedges, reeds, and grasses.

Profile description in cultivated areas:

- 0 to 7 inches, very dark brownish-gray to very dark-gray very friable fine sandy loam, relatively high in organic-matter content; strongly acid.
- 7 to 13 inches, very dark-gray loose loamy fine sand to fine sand, relatively high in organic-matter content; strongly to very strongly acid.
- 13 inches+, mottled gray, yellow, and brown fine sand to sand; extends to depths of 6 feet or more; the yellow color often occurs as large blotches or streaks; upper part of the horizon strongly to very strongly acid; a gradual change to medium acid below a depth of about 6 feet.

The variations from the above profile description are in the color and organic content of the first two layers.

Use and management.—A large proportion of Newton fine sandy loam is at present in forest or brush. This soil is relatively low in productivity, principally because of strong acidity and the unfavorable moisture conditions often occurring in the growing season. The strong acidity makes it very difficult to obtain stands of leguminous hay. The organic-matter content and nitrogen supply are relatively high, but the content of phosphate and potash is relatively low.

The crops are corn, wheat, soybeans, and hay, and some vegetables and minor field crops. Corn yields are often materially reduced because of the droughtiness in summer and early in fall. Soybeans usually follow corn in the rotation. Rye is as well or perhaps somewhat better adapted than wheat, and it occasionally takes the place of wheat in the rotation. Some oats are grown, although they are not so well adapted as either wheat or rye.

The principal hay crops are a mixture of timothy, alsike, and clover, and some redtop. Good stands of alfalfa and clover are somewhat difficult to obtain, even after heavy applications of lime. A considerable part of this soil is in permanent pasture of fair to low quality. Broomsedge and various weeds are the principal vegetation on many of the permanent pasture areas. Good stands of bluegrass, however, occur on some areas that have been limed and given rather heavy applications of phosphate fertilizer. A few areas are used for vegetables.

Suitable rotations are given under management group 9 in table 10.

Newton loam (0 to 2 percent slopes) (N_B).—This soil was developed on loose sands of Wisconsin glacial age. It is a very poorly drained, dark-colored member of the soil catena that also includes the excessively drained Plainfield, moderately well drained Berrien, imperfectly drained Morocco, and very poorly drained, very dark-colored Dillon soils. Morocco soils do not occur extensively enough in this county to be mapped separately. Newton loam occurs in shallow depressions and on broad depressed flats. Parts of the areas have been artificially drained to permit cultivation. The relief is nearly level, and most of the moisture falling on the soil readily permeates it. The native vegetation included water-loving trees, rushes, sedges, and grasses.

Profile description in cultivated areas:

- 0 to 7 inches, very dark brownish-gray to very dark-gray friable medium granular loam high in organic-matter content; strongly acid.
- 7 to 13 inches, dark-gray to very dark brownish-gray loam to sandy loam; relatively high in organic-matter content; very strongly acid.
- 13 inches+, mottled gray, yellow and brown fine sand to sand; irregular mottling, with conspicuous blotches and streaks of yellow; continues to depths of 10 to 20 feet or more; strongly to very strongly acid in the upper part; a gradual change to medium acid below 5 feet.

The variations are chiefly in the thickness and organic-matter content of the first two layers.

Use and management.—A large part of Newton loam is at present in forest. The high acidity and loose nature of the profile contribute to the relatively low productivity of this soil. The organic-matter content and nitrogen supplies are relatively high, but the supplies of phosphate and potash are low. The crops grown on the cultivated areas are chiefly corn, wheat, soybeans, sweet corn, and hay. Many of the cultivated areas are somewhat droughty in summer and early fall, and moisture appears to be the limiting factor for corn as well as most other crops. Soybeans are rather extensively grown and they usually follow corn in the rotation.

Alfalfa and clover stands are difficult to obtain because of the high acidity. Hay crops include timothy, some alsike and clover, and some redtop. A considerable part of this soil is in pasture of low quality. The pasture consists principally of broomsedge and various weeds, and a small proportion of bluegrass. A few excellent stands of bluegrass, however, were observed on this soil during the mapping season.

Suitable management practices are given under management group 9 in table 10.

Nyona loam (0 to 2 percent slopes) (Nc).—This is a very poorly drained dark-colored soil developed on poorly assorted highly calcareous gravel and sand, with minor quantities of silt and clay. It occurs in shallow depressions and on broad depressed flats in the northwestern part of the county, closely associated with Lear and Bronson soils. This soil, together with Lear loam, is included in a prairie border area of the outwash plains. Most of the water falling on the soil is removed internally. Removal of excess water is rather easily accomplished, where outlets are available, by lowering the general water table of the area. Both open ditches and tile drains are used. Nyona loam differs from Brookston soils in having a higher content of gravel in the subsoil and somewhat poorly assorted substrata. Westland soils differ from Nyona loam in having been developed on highly stratified gravel. Natural drainage conditions are very similar to those of the above-mentioned soils. Native vegetation included water-tolerant trees.

A profile description in cultivated areas:

- 0 to 7 inches, very dark brownish-gray to very dark-gray friable loam; high organic-matter content; slightly acid to neutral.
- 7 to 14 inches, dark-gray to very dark-gray heavy loam to silty clay loam containing considerable rounded gravel; breaks into coarse granular or small subangular blocky aggregates; organic-matter content relatively high; neutral to mildly alkaline.
- 14 to 32 inches, mottled gray, yellow, and brown heavy loam to clay loam containing a considerable proportion of gravel and small rounded glacial pebbles; breaks into irregular sized and shaped pieces that are only

slightly plastic when moist and slightly hard when dry; neutral to mildly alkaline.

32 inches +, gray and light-yellow highly calcareous and not well-assorted gravel and sand, with a small proportion of silt and clay.

Variations are chiefly in the organic-matter content and the color of the first two horizons, the content of gravel and pebbles throughout the profile, and the depth to calcareous material.

Use and management.—Practically all of Nyona loam has been drained and cleared of timber and is under cultivation to the general farm crops of the region. These are field corn, sweet corn, soybeans, wheat, oats, and hay crops, including alfalfa grown alone or a mixture of alfalfa, clover, timothy, and alsike. Special field and hay crops and vegetables are grown to a minor extent. The soil is well suited to corn and soybeans, which are probably the dominant crops. Where Nyona loam forms a large part or all of the field unit, corn is grown for 2 or more consecutive years and is usually followed by wheat. Oats can take the place of wheat in the rotation. Fertilizers are needed for all crops.

It is not necessary to apply lime for the success of clover and alfalfa. Good stands of these crops are obtained but there is some danger of loss caused by standing water. Some areas that are apparently somewhat overdrained have lower yields than other areas. This is especially noticeable in seasons of low moisture conditions.

Suitable management practices are summarized under management group 8 in table 10.

Ottawa loamy fine sand (2 to 10 percent slopes) (O_A).—This is an excessively drained soil developed on sandy glacial outwash materials over calcareous glacial till or lacustrine clays. It occurs on undulating to rolling relief, occasionally in dune-shaped areas that extend above the general level of the area. Surface runoff is slow, and the loose coarse surface soil and subsoil permit rapid movement of water through the soil. Wind erosion is potentially severe on cultivated areas. Native vegetation included black and Hills oaks.

Profile description in cultivated areas:

0 to 7 inches, grayish-brown to light yellowish-brown loamy fine sand, low in organic-matter content; medium to strongly acid.

7 to 60 inches, brownish-yellow loose loamy sand to fine sand that changes gradually to sand with depth; below 3 or 4 feet the color may be pale yellow; contains an occasional lens or thin layer of pale-yellow slightly coherent material; strongly acid in the upper part of the horizon, changing gradually to slightly acid in the lower part.

60 inches +, pale-yellow or gray and light-yellow calcareous loam glacial till or thin strata of sand, silt, or clay.

Variations are chiefly in the depth to heavy-textured material, which is 4 to more than 10 feet.

Use and management.—Ottawa loamy fine sand is droughty for the general farm crops of the area. Corn, soybeans, and hay crops, including alfalfa and timothy, are the principal crops, although some areas are used for special crops such as berries, melons, and cucumbers. The water-holding capacity is extremely low, and corn and soybeans are not well adapted. Alfalfa is probably better suited than other hay crops, although large applications of lime, phosphate, and potash are necessary to obtain and maintain a stand. This soil is better suited to melons, berries, cucumbers, and such crops than to field crops. A considerable part remains in forest, and a few areas are

idle and support a growth of various weeds and a small quantity of bluegrass.

Suitable management practices are summarized under management group 3 in table 10.

Plainfield fine sand (1 to 6 percent slopes) (PA).—This is a light-colored soil developed on loose acid sand. It is an excessively drained member of the soil catena that also includes the moderately well drained Berrien, imperfectly drained Morocco, very poorly drained dark-colored Newton, and very poorly drained very dark-colored Dillon soils. Morocco soils do not occur in sufficient extent in this county to be mapped separately. Plainfield fine sand occurs on nearly level to undulating relief, often as low dunelike areas. It is mapped principally in the northwestern part of the county. There is very little surface runoff because of the loose porous nature of the entire profile. Moisture moves through the soil very rapidly. The material was probably originally deposited by water from the retreating ice sheets and has been subsequently shifted and reworked by wind action. Wind erosion is potentially severe on some areas, and blowouts—where the sand has been blown out for a depth of 4 or more feet—occur here and there. Native vegetation included predominantly black and Hills oak.

Profile description in cultivated areas:

0 to 7 inches, grayish-brown to light yellowish-brown incoherent loamy fine sand; medium to strongly acid.

7 inches+, brownish-yellow to pale-yellow loose fine sand or sand with an occasional streak, pocket, or seam of slightly coherent yellow sandy material; continues to depths of 4 to 20 feet or more with only slight color variations.

Use and management.—Plainfield fine sand is a very droughty soil, and the supply of plant nutrients is very low. The principal crops on the cultivated areas are rye, corn, wheat, and alfalfa; a few areas are in melons. It is not well adapted, even with heavy fertilization, to corn, and yields are usually restricted by its low moisture-supplying capacity. Rye produces better yields than either wheat or oats. Fair stands of alfalfa are obtained after rather heavy applications of lime and phosphate fertilizer. Good stands of clover or timothy are seldom obtained. This soil responds well to fertilizer and manure, but plant food is quickly leached because of the low clay content and very rapid internal soil drainage. A large proportion is in forest.

Suitable management practices are summarized under management group 3 in table 10.

Plainfield fine sand, rolling phase (10 to 20 percent slopes) (PB).—This phase includes areas of Plainfield fine sand that occur on rolling dunelike topography with slopes of 10 percent or more. Wind erosion is severe on cleared areas, and blowouts—areas where the wind has removed the soil to depths of 3 to 4 feet or more—are frequent. This soil occurs in association with Plainfield fine sand, occasionally on the leeward slopes. The profile is similar to that of the normal phase of Plainfield fine sand. This phase is used largely for forest and low-grade pasture; only a few areas are under cultivation. It is poorly suited to cultivated crops under present economic conditions.

Management practices are given under management group 3 in table 10.

Riverwash (0 to 2 percent slopes) (R).—Areas of Riverwash occur as islands in the Eel and Wabash Rivers and include a mixture of gravel, sand, rocks of various sizes, and small quantities of finer textured material. They are only a little above the river level at its normal stage, and their size and shape may be considerably changed by a single flood. They support a scant growth of weeds and shrubs and are nonagricultural.

Russell silt loam (2 to 6 percent slopes) (Rp).—This is the well-drained member of the soil catena that also includes the imperfectly drained Fincastle, poorly drained Delmar, very poorly drained dark-colored Brookston, and very poorly drained very dark-colored Kokomo soils. It is developed on relatively thin (12 to 36 inches) deposits of silt (probably loess) over calcareous Wisconsin glacial till. Russell silt loam is similar to Miami silt loam in drainage conditions, but differs in having a more silty surface soil and upper subsoil, a smaller quantity of grit and fine sand in the upper subsoil, a more acid reaction of the surface and subsoil horizons, and a greater depth to calcareous till. It occurs on undulating to gently rolling relief, closely associated with Fincastle and Brookston soils. Surface drainage is good to excessive, and the movement of moisture and air through the profile is moderate. The erosion hazard is severe, especially on the more rolling areas. The native vegetation was deciduous trees, chiefly white oak, hickory, ash, elm, and maple.

Profile characteristics in cultivated areas:

- 0 to 7 inches, grayish-brown to light yellowish-brown, smooth, friable, granular silt loam, relatively low in organic-matter content; medium acid.
- 7 to 10 inches, light yellowish-brown to brownish-yellow friable, heavy silt loam, usually free of grit and pebbles; permeable to roots and moisture; medium to strongly acid.
- 10 to 18 inches, brownish-yellow to yellowish-brown silty clay loam (usually free of fine gravel); breaks into subangular blocky aggregates from $\frac{1}{4}$ to $\frac{1}{2}$ inch in diameter that are easily crushed into coarse granules when wet but are hard when dry; strongly to medium acid.
- 18 to 36 inches, brownish-yellow to yellowish-brown compact silty clay loam; breaks into subangular blocky aggregates from $\frac{1}{4}$ to $1\frac{1}{4}$ inches in diameter; a thin coating of gray colloidal material occurs on many of the cleavage faces, giving the material a somewhat mottled appearance in place, but the gray color disappears when the material is crushed; strongly to medium acid.
- 36 to 45 inches, brownish-yellow silty clay loam containing much grit and numerous small rock fragments; less compact and more friable than the above horizon; breaks into irregular-sized subangular pieces; medium to slightly acid.
- 45 inches +, gray and yellow compact calcareous loam glacial till composed of unsorted silt, clay, sand, and rock fragments.

Variations are chiefly in the texture and thickness of the different horizons and the depth to calcareous till. Russell silt loam mapped south of the Wabash River and Pipe Creek often occurs in close association with Miami silt loam. The profile characteristics vary and are similar in many cases to those of Miami silt loam, except that the depth to calcareous till is considerably greater. The thickness of the silty material varies from place to place. In many instances the separation between Russell silt loam and Miami silt loam south of the Wabash River has been drawn arbitrarily, and Russell-like profiles may occur in small areas within the regions of Miami and associated soils.

Use and management.—The rotation in general use consists of corn, wheat or oats, soybeans, and hay crops, including alfalfa grown alone or a mixture of alfalfa, clover, alsike, and timothy. This is altered to include special field and hay crops and an occasional vegetable crop. The surface soil is relatively low in organic-matter content and nitrogen, and it is necessary to apply all available organic matter in order to maintain or increase productivity on this soil. Erosion is potentially severe on most areas, especially those with steeper slopes; and the rotation should include, where feasible, a large proportion of small grain and hay crops and a small proportion of clean-cultivated crops. For legumes, it is necessary to apply larger quantities of lime to this soil than to Miami soils.

Corn usually follows hay crops in the rotation. Soybeans and wheat are well adapted. Oats occasionally take the place of wheat in the rotation. Alfalfa and clover are well adapted, providing sufficient lime is used to bring the pH to 6.0 or higher. Bluegrass pasture is well suited to this soil, providing sufficient lime and phosphate fertilizer are used. Small isolated areas remain in forest.

Suitable management practices are summarized under management subgroup 1A in table 10.

Russell silt loam, sloping phase (10 to 20 percent slopes) (R₂).—The profile characteristics of the sloping phase are similar to those of the normal phase except that the various horizons are somewhat thinner and the depth to calcareous till is less. Erosion is potentially severe on cultivated areas and on permanent pasture, and many areas are moderately to severely eroded. On such areas a considerable part of the original surface soil has been removed and the plow soil, or present surface soil, includes a part of the subsoil. Till conditions are poor, and the organic-matter content is extremely low. Surface runoff is rapid.

Use and management.—Since Russell silt loam, sloping phase, often occurs in close association with areas of the normal phase, it is cultivated to the same crops. These include corn, soybeans, wheat or oats, and hay crops. Crop yields are considerably lower on this phase than on the normal phase. The more sloping areas are better adapted to alfalfa or to permanent pasture than to cultivated crops. It is essential that erosion control practices be used and that rotations including a predominance of small grain and hay crops and a small proportion of intertilled crops be used in order to help control erosion. A considerable proportion of the soil is in permanent bluegrass pasture. The quality of these pastures could be materially improved by the use of sufficient lime and phosphate fertilizer and by weed control. A few areas remain in forest.

Suitable management practices are summarized under management subgroup 1B in table 10.

Russell silt loam, steep phase (20 to 50 percent slopes) (R₃).—The profile characteristics of the steep phase are somewhat similar to those of the normal phase but vary according to the steepness of the slopes. The various horizons are much thinner, and the depth to calcareous till is considerably less than for the normal phase. Russell silt loam, steep phase, is mapped principally adjacent to the valleys of the Wabash River in rather long narrow tracts between the upland areas of Russell and other soils and the terrace or first bottom areas in the valley.

Use and management.—Practically all of this steep phase is in forest or brush growth. It is essentially nonagricultural, and forest is probably the best use. A few areas, however, having the milder slopes are suitable for permanent bluegrass pasture.

Suitable management practices are summarized under management subgroup 1C in table 10.

Russell-Miami silt loams (2 to 6 percent slopes) (RA).—This complex includes Russell silt loam and Miami silt loam in such close association that it is impracticable to separate them on the map. The profile characteristics in practically all of the areas range from those given for Russell silt loam (p. 79) to those given for Miami silt loam (p. 71). It is probable that windblown silts, or loess, have been deposited over the surface, the thickness varying from place to place and within the same area. The thickness of the silty surface and upper subsoil is 0 to 24 inches or more, and the depth to calcareous till is 36 to 75 inches within a horizontal distance of a few hundred feet. Also, the till is variable in texture, mineralogical content, and depth to calcareous material within short horizontal distances. Numerous spots of undetermined extent have friable sandy lower subsoils and calcareous sandy till at depths of 60 inches or more.

The boundary line between this separation and Russell silt loam is drawn somewhat arbitrarily, and areas having these complex characteristics may occur within the areas of Russell silt loam.

Use and management.—The crop rotation in general use on Russell-Miami silt loams consists of corn, oats, wheat, soybeans, and hay, including chiefly a legume-grass mixture. The rotation is often modified by the proportion of the associated soils in a field unit. The organic-matter content is low, and both barnyard manure and green-manure crops need to be turned under. Liming is necessary for the best growth of alfalfa and clovers. The more sloping areas are susceptible to erosion under intertilled crops, and a cover crop such as wheat or rye should be planted on these areas to protect the soil in fall, winter, and early spring. Some areas are in bluegrass pasture, the quality varying from poor to excellent. The livestock-carrying capacity of most of the permanent pastures could be increased by a pasture-improvement program including liming, fertilization, re-seeding, and weed control.

Suitable management practices are summarized under management subgroup 1A in table 10.

Russell-Miami silt loams, sloping phases (10 to 20 percent slopes) (RB).—This separation often occurs adjacent to small drainageways, in close association with Russell-Miami silt loams. The profile characteristics have the same variability as described for Russell-Miami silt loams, except that the thickness of the horizons and the depth to calcareous till is less. Erosion is potentially severe on cultivated areas and on permanent pasture. Numerous areas are moderately to severely eroded, and a considerable part of the surface soil and in some places a part of the subsoil have been removed. The plow soil, or present surface soil, in these areas includes a part of the original subsoil.

Use and management.—Crops on cultivated areas are corn, wheat, oats, soybeans, and hay, including clover, alfalfa, and timothy.

Yields are somewhat lower than those obtained on the associated smoother areas. A considerable part is in bluegrass pasture.

Suitable management practices are summarized under management subgroup 1B in table 10.

Wallkill silt loam (0 to 2 percent slopes) (WA).—This soil consists of a relatively thin recent alluvial deposit of light-colored mineral material over muck. The mineral material was washed from surrounding upland areas of Wisconsin drift. Wallkill silt loam occurs in small isolated tracts or as a band or transitional area between the upland mineral soils and the depressions or broad depressed flats of muck soils. Natural drainage conditions are poor to very poor, but a considerable part of the soil has been drained artificially for crop production. Native vegetation included water-tolerant trees and grasses.

Profile description in cultivated areas:

- 0 to 7 inches, grayish-brown to brownish-gray friable medium granular silt loam; organic-matter content variable but usually relatively low; slightly acid to neutral.
- 7 to 15 inches, brownish-gray heavy silt loam, slightly mottled with gray and light yellow in the lower part; slightly acid to neutral.
- 15 inches +, very dark-gray to nearly black granular muck that grades into yellow or brown mucky and peaty material below a depth of 30 to 36 inches; slightly acid to neutral.

The total thickness of the first two layers is 8 to 30 inches or more. Where the greatest thickness of mineral material occurs, the color of the lower deposits is often mottled gray, yellow, and brown. Included are a few areas where the surface texture is loam.

Use and management.—Wallkill silt loam is usually closely associated with Carlisle muck or Carlisle silty muck, and the crops are similar to those on the associated soils. Corn, soybeans, and vegetables are the principal crops on the better drained areas; wheat or rye and hay crops are occasionally grown. The soil is fairly well adapted to corn, soybeans, and vegetables. It is not well adapted to small grains because of the danger of flooding. The inadequately drained areas are in permanent bluegrass pasture or are idle.

Suitable management practices are summarized under management group 10 in table 10.

Washtenaw silt loam (0 to 2 percent slopes) (WB).—This very poorly drained soil is characterized by an accumulation of light-colored mineral material washed from surrounding upland areas and deposited over the dark-colored Brookston and Kokomo soils. It is mapped in small isolated areas throughout the county, usually in association with Brookston and Kokomo soils. It occurs in depressions and potholes, or as a band between the upland areas of Miami and associated soils and the Brookston and Kokomo soils. A considerable part has been artificially drained to permit cropping, although drainage is variable and is dependent to a large degree upon the feasibility of cutting tile drainage lines through the adjoining upland areas. Native vegetation included water-loving trees such as maple, elm, and associated species.

Profile description of cultivated areas:

- 0 to 7 inches, grayish-brown to brownish-gray friable granular silt loam; organic-matter content variable but usually lower than that in the Brookston soils; slightly acid to neutral.

- 7 to 15 inches, brownish-gray heavy silt loam having platy or laminated structure; lower few inches occasionally slightly mottled light-gray and yellow; slightly acid to neutral.
- 15 inches+, dark brownish-gray to very dark brownish-gray loam to silty clay loam; this horizon is the former surface of either Kokomo or Brookston soils and grades at various depths into mottled gray, yellow, and brown heavy-textured material or to light-gray silty clay loam or heavier textured material; neutral.

The first two layers, representing the silted-in material, are 8 to 25 inches or more in thickness, and the content of organic matter in the surface and subsoil is also variable. Included are a few areas that have a loam surface texture.

Use and management.—The greater part of Washtenaw silt loam is at present in permanent pasture or forest. Where properly drained it is cropped the same as the associated soils; rotations usually include corn, wheat or oats, and soybeans or hay crops. Corn and soybean yields are only slightly lower than those obtained on Brookston soils. Small grains are subject to the hazard of flooding, especially early in spring. The quality of the permanent pasture is variable and depends upon the adequacy of drainage.

Suitable management practices are summarized under management group 7 in table 10.

Westland silty clay loam (0 to 2 percent slopes) (Wc).—This soil was developed on highly calcareous glaciofluvial gravel of Wisconsin age. It is the very poorly drained dark-colored member of the soil catena that also includes the well to somewhat excessively drained Fox, moderately well drained Bronson, imperfectly drained Homer, and very poorly drained very dark-colored Abington soils. It occurs in slightly depressional areas or in depressed flats, often in old glacial drainageways. It is associated principally with the above-mentioned soils on the outwash plains and terrace areas, principally adjacent to the Wabash and the Eel Rivers.

The water table was at the surface or slightly below it most of the year, but the greater part of the soil has now been artificially drained to permit cropping. Drainage is rather easily accomplished, where outlets are available, by lowering the general water table in the loose sand and gravel substrata. Both open ditches and tile are used. Native vegetation consisted of water-tolerant trees, chiefly red maple, elm, ash, and blackgum and some marsh grasses.

Profile characteristics in cultivated areas:

- 0 to 7 inches, dark-gray to very dark brownish-gray silty clay loam, relatively high in organic-matter content; neutral.
- 7 to 14 inches, dark-gray to dark brownish-gray silty clay loam to clay loam, with a few light-yellow or brown mottlings in the lower part of the horizon; organic-matter content relatively high and numerous pieces of glacial gravel present; permeable to moisture movements and to plant roots; neutral.
- 14 to 50 inches, mottled gray, yellow, and brown waxy and gravelly clay loam; breaks into large angular pieces that are plastic when moist and hard when dry; numerous rounded pebbles and pieces of gravel in the upper part of the horizon, increasing in quantity with depth; neutral.
- 50 inches+, gray and light-yellow stratified calcareous gravel and sand.

Variations from the above description are in the color and organic-matter content of the surface soil and subsurface soil, the color and texture of the subsoil; the depth to mottling; and the depth to calcareous gravel, which ranges from 40 to 65 inches.

Use and management.—The management practices on Westland silty clay loam are governed by the extent of associated soils in a given field, unless this soil comprises all or a large part of it. Rotations consist of corn, wheat or oats, soybeans, and hay crops, including alfalfa grown alone or a mixture of alfalfa, clover, alsike, and timothy. This rotation is varied to include minor hay and field crops and vegetable crops. Where this soil comprises the greater part or all of the field, corn is often grown for 2 or more consecutive years. The content of organic matter and nitrogen is relatively high; that of phosphate and potash, however, is somewhat lower and fertilizers high in them should be used. Lime is not required for the success of legumes.

Corn and soybeans are well adapted to this soil. Unless drainage is adequate, small grains are not so well adapted as corn and soybeans. Wheat usually follows corn in the rotation. It is occasionally damaged by excess moisture in winter and spring; and the grain tends to lodge, because of the high organic-matter and nitrogen content of the soil, unless sufficient phosphate and potash fertilizer are used. Oats take the place of wheat in the rotation. There is also danger of oats lodging, although the newer stiff-stemmed varieties are less susceptible.

Alfalfa is well adapted, provided drainage is adequate. There is some loss, however, from high moisture conditions and heaving in winter and early in spring. A mixture of clover, alfalfa, timothy, and alsike is grown rather extensively. Excellent stands of permanent bluegrass pasture are obtained on this soil, although some could be improved by weed control. A few areas remain in forest.

Suitable management practices are summarized under management group 8 in table 10.

YIELDS AND PRODUCTIVITY OF CASS COUNTY SOILS

The soils of Cass County are listed in table 7, and estimated average acre yields of the principal crops to be expected over a period of years under two levels of management are given for each soil.

The estimates in columns A under each crop indicate yields obtained under prevailing practices. These practices, on most of the soils, include the use of some but usually insufficient amounts of commercial fertilizer; more or less regular crop rotations that usually contain a too high proportion of intertilled crops; artificial drainage, where necessary; application of some but often not sufficient lime; and the use of barnyard manure and some green manure.

In columns B, yields under more careful and intense practices are given. Under such practices the rotation is more regular, or it includes the proper proportion of clean cultivated crops (as corn and soybeans); small grains; hay crops having a high percentage of clovers and alfalfa; and vegetable and special crops where suitable. The quantity of lime applied is ascertained by accurate soil tests, and the quantity and analyses of the commercial fertilizers used are based upon the plant-food requirements for a crop or for all crops in the rotation. Adequate artificial drainage is installed where necessary; improved varieties and high-quality seed are used; and where needed, mechanical measures such as contour tillage, stripcropping, terracing, and diversion ditches are used to control erosion. Some farmers exceptionally

skilled in the selection and application of all the elements of good management may obtain average yields substantially above those shown in columns B.

The estimated acre yields are based primarily on interviews with farmers, the county agricultural agent, and members of the Purdue University Agricultural Experiment Station; direct observation by members of the soil survey party; and results obtained on experimental farms by the experiment station. They are presented only as estimates of the average production to be expected over a period of years, according to the two broadly defined types of management. It is realized that they may not apply directly to specific tracts of land for any particular year; as the soils shown on the map may vary somewhat from place to place, management practices differ slightly from farm to farm, and climatic conditions fluctuate from year to year. On the other hand, these estimates appear to be as accurate as can be obtained without further detailed and lengthy investigations, and they serve to bring out the relative productivity of the soils shown on the map.

Yields alone do not determine the relative worth of a soil for crops. The ease or difficulty of tillage and the ease or difficulty with which productivity is maintained, for example, also determine the general desirability of a soil for agricultural use. Steepness of slope, presence or absence of stone, the resistance to tillage caused by the consistence or structure of the soil, and the size and shape of areas are characteristics that influence the relative ease with which soils can be tilled. Inherent fertility and susceptibility to erosion are characteristics that influence the ease in maintaining soil productivity at a given level. In some cases the quality of crops differs according to the soil but the yields do not show this difference. Nevertheless for most crops and most soils, the yields that may be expected over a period of years afford the only quantitative expression of the productivity of the soil.

The expected yields of various crops on the soils of the county have been converted into indexes in table 8.

The rating compares the productivity of each of the soils for each crop with a standard of 100. This standard index represents the approximate average acre yield obtained without the use of fertilizer and other amendments on the more extensive and better soils of the regions of the United States in which the crop is most widely grown. An index of 50 indicates that the soil is about half as productive of the specified crop as a soil having the standard index. Soils given amendments, as lime or commercial fertilizer, or unusually productive soils may have productivity indexes of more than 100 for some crops.

The indexes of the productivity rating table (table 8) are the expected yields of table 7 expressed as percentages of the standard yields adopted for the county as a whole:

$$\text{Productivity rating index} = \frac{\text{expected yield}}{\text{standard yield}} \times 100$$

The standard yields on which the indexes are based are given in the table under the names of the crops for which the ratings are given. Columns A and B under each crop refer to two levels of management and correspond to similar columns in the table of expected yields (table 7) for which the levels of management are defined.

TABLE 7.—*Estimated average acre yields to be expected over a period of years on*

[Yields in column A are expected under prevailing practices; those in column B are expected under management that include crop rotations, erosion-control practices, and the use of legumes, commercial green manures. Absence of a yield figure indicates that the crop is not commonly grown under prevailing practices.]

Soil	Corn		Wheat		Oats	
	A	B	A	B	A	B
Abington loam:						
Drained ¹	Bu. 50	Bu. 60	Bu. 15	Bu. 20	Bu. 30	Bu. 45
Undrained ²	10	---	5	---	10	---
Abington silty clay loam:						
Drained ¹	50	60	15	20	30	45
Undrained ²	10	---	5	---	10	---
Aubbeenaubee fine sandy loam.....	32	40	16	18	35	40
Bellefontaine fine sandy loam.....	25	32	15	17	20	25
Bellefontaine loam.....	30	37	16	18	22	27
Berrien fine sandy loam.....	22	30	11	15	---	---
Berrien loamy fine sand.....	20	27	8	12	---	---
Bethel silt loam.....	25	40	10	15	20	25
Bronson fine sandy loam.....	30	37	13	17	27	35
Brookston loam:						
Drained ¹	50	60	20	25	35	45
Undrained ²	25	---	5	---	15	---
Brookston silty clay loam:						
Drained ¹	50	60	17	25	37	47
Undrained ²	25	---	5	---	15	---
Carlisle muck:						
Drained ¹	35	60	12	18	25	35
Undrained ²	10	---	---	---	---	---
Carlisle silty muck:						
Drained ¹	35	60	12	18	25	35
Undrained ²	10	---	---	---	---	---
Coloma fine sand.....	17	25	7	11	10	15

Coloma loamy fine sand.....	20	30	8	12	12	17
Conover fine sandy loam.....	37	45	17	20	37	42
Conover loam.....	50	60	20	25	40	50
Crosby fine sandy loam.....	35	42	17	20	35	40
Crosby loam.....	42	50	18	22	40	45
Crosby silt loam.....	45	55	18	22	40	45
Delmar silt loam.....	25	40	10	15	20	25
Delmar-Bethel silt loams.....	25	40	10	15	20	25
Dillon fine sandy loam:						
Drained ¹	15	27	7	12	15	27
Undrained ²						
Bel loam.....	45	55	13	20	30	35
Bel silt loam.....	50	60	15	22	30	35
Farmington silt loam.....						
Fincastle silt loam.....	42	55	18	22	40	45
Fincastle-Crosby silt loams.....	42	55	18	22	40	45
Fox fine sandy loam.....	25	35	15	20	20	25
Deep phase.....	30	40	16	21	20	25
Fox loam.....	35	50	17	22	22	27
Steep phase.....						
Fox silt loam.....	35	50	20	25	25	30
Deep phase.....	40	55	20	25	30	35
Genesee fine sandy loam.....	35	40	12	17	25	30
Genesee loam.....	50	55	20	22	40	45
Genesee silt loam.....	55	60	20	22	40	45
Gravel pits.....						
Griffin fine sandy loam.....	35	40	12	17	25	30
Hartman silt loam.....	40	50	19	25	40	45
Hartman loam.....	35	45	17	22	30	45
Homer fine sandy loam.....	30	40	13	17	27	35
Homer silt loam.....	40	50	17	22	40	45
Kokomo loam:						
Drained ¹	45	60	15	20	30	45
Undrained ²	10		5		10	
Kokomo silty clay loam:						
Drained ¹	45	60	15	20	30	45
Undrained ²	10		5		10	
Lear loam:						
Drained ¹	45	55	15	20	30	40
Undrained ²	10		5		10	

TABLE 7.—Estimated average acre yields to be expected over a period of years on the soil

Soil	Corn		Wheat		Oats	
	A	B	A	B	A	B
	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.
Limestone rockland						
Made land						
Maumee fine sandy loam:						
Drained ¹	30	40	12	16	20	27
Undrained ²	10					
Maumee loam:						
Drained ¹	35	45	15	18	25	37
Undrained ²	10					
Metea fine sandy loam	30	40	17	22	25	37
Miami fine sandy loam	32	40	17	22	25	37
Miami loam	40	50	20	25	35	45
Miami silt loam	45	55	20	25	35	45
Sloping phase	25	35	12	17	20	30
Steep phase						
Millsdale silty clay loam:						
Drained ¹	45	55	15	20	30	40
Undrained ²	10		5		10	
Milton silt loam	40	45	20	25	35	45
Newton fine sandy loam:						
Drained ¹	15	27	7	13	15	30
Undrained ²						
Newton loam:						
Drained ¹	17	30	8	15	17	32
Undrained ²						
Nyona loam:						
Drained ¹	45	55	15	20	30	40
Undrained ²	10		5		10	
Ottawa loamy fine sand	20	30	8	12	12	17

Plainfield fine sand.....	15	25	6	10	12	17
Rolling phase.....	---	---	---	---	---	---
Riverwash.....	---	---	---	---	---	---
Russell silt loam.....	45	55	20	25	35	45
Sloping phase.....	25	35	12	17	20	30
Steep phase.....	---	---	---	---	---	---
Russell-Miami silt loams.....	45	55	20	25	35	45
Sloping phases.....	25	35	12	17	20	30
Wallkill silt loam:	---	---	---	---	---	---
Drained ¹	40	60	12	17	25	35
Undrained ²	10	---	---	---	---	---
Washtenaw silt loam:	---	---	---	---	---	---
Drained ¹	45	55	15	22	30	40
Undrained ²	10	---	5	---	10	---
Westland silty clay loam:	---	---	---	---	---	---
Drained ¹	50	60	17	22	35	45
Undrained ²	25	---	5	---	15	---

¹ Artificially drained.

² Without artificial drainage.

TABLE 8.—*Productivity ratings of soils in Cass County, Ia*

[Yields represented by indexes in column A indicate the average expectable acre yields over a period of years under those in column B the average expectable acre yields with improved methods of farm management and control practices, the use of legumes, commercial fertilizer, lime, and barnyard and green manure, and the crop is not commonly grown under the management level specified. No index given indicates that the crop is undrained because under such management they would not be used for the crop.]

Soil ¹	Crop productivity					
	Corn (100= 50 bu.)		Wheat (100=25 bu.)		Oats (100= 50 bu.)	
	A	B	A	B	A	B
Genesee silt loam.....	110	120	80	90	80	90
Abington loam (drained).....	100	120	60	80	60	90
Abington silty clay loam (drained).....	100	120	60	80	60	90
Brookston loam (drained).....	100	120	80	100	70	90
Brookston silty clay loam (drained).....	100	120	70	100	75	95
Conover loam.....	100	120	80	100	80	100
Eel silt loam.....	100	120	60	90	60	70
Genesee loam.....	100	110	80	90	80	90
Westland silty clay loam (drained).....	100	120	70	90	70	90
Kokomo silty clay loam (drained).....	90	120	60	80	60	90
Kokomo loam (drained).....	90	120	60	80	60	90
Crosby silt loam.....	90	110	70	90	80	90
Eel loam.....	90	110	50	80	60	70
Lear loam (drained).....	90	110	60	80	60	80
Millsdale silty clay loam (drained).....	90	110	60	80	60	80
Nyona loam (drained).....	90	110	60	80	60	80
Washtenaw silt loam (drained).....	90	110	60	90	60	80
Crosby loam.....	85	100	70	90	80	90
Fincastle-Crosby silt loams.....	85	110	70	90	80	90
Fincastle silt loam.....	85	110	70	90	80	90
Fox silt loam, deep phase.....	80	110	80	100	60	70
Hartman silt loam.....	80	100	75	100	80	90
Homer silt loam.....	80	100	70	90	80	90

Miami loam-----	80	100	80	100	70	90
Miami silt loam-----	90	110	80	100	70	90
Milton silt loam-----	80	90	80	100	70	90
Russell silt loam-----	90	110	80	100	70	90
Russell-Miami silt loams-----	90	110	80	100	70	90
Walkill silt loam (drained)-----	80	120	50	70	50	70
Conover fine sandy loam-----	75	90	70	80	75	85
Carlisle muck (drained)-----	70	120	50	70	50	70
Carlisle silty muck (drained)-----	70	120	50	70	50	70
Crosby fine sandy loam-----	70	85	70	80	70	80
Fox loam-----	70	100	70	90	45	55
Fox silt loam-----	70	100	80	100	50	60
Genesee fine sandy loam-----	70	80	50	70	50	60
Hartman loam-----	70	90	70	90	60	90
Griffin fine sandy loam-----	70	80	50	70	50	60
Maumee loam (drained)-----	70	90	60	70	50	75
Aubbeenaubee fine sandy loam-----	65	80	65	70	70	80
Bellefontaine loam-----	60	75	65	70	45	55
Bronson fine sandy loam-----	60	75	50	70	55	70
Fox fine sandy loam, deep phase-----	60	80	65	85	40	50
Homer fine sandy loam-----	60	80	50	70	55	70
Maumee fine sandy loam (drained)-----	60	80	50	65	40	55
Metee fine sandy loam-----	60	80	70	90	50	75
Miami fine sandy loam-----	65	80	70	90	50	75
Bellefontaine fine sandy loam-----	50	65	60	70	40	50
Bethel silt loam-----	50	80	40	60	40	50
Delmar silt loam-----	50	80	40	60	40	50
Delmar-Bethel silt loams-----	50	80	40	60	40	50
Fox fine sandy loam-----	50	70	60	80	40	50
Russell-Miami silt loams, sloping phases-----	50	70	50	70	40	50
Miami silt loam, sloping phase-----	50	70	50	70	40	60
Russell silt loam, sloping phase-----	50	70	50	70	40	60
Brookston loam (undrained)-----	50	70	50	70	40	60
Brookston silty clay loam (undrained)-----	50	70	50	70	40	60
Westland silty clay loam (undrained)-----	50	---	20	---	30	---
Berrien fine sandy loam-----	45	60	45	60	---	---
Berrien loamy fine sand-----	40	55	30	50	---	---
Coloma loamy fine sand-----	40	60	30	50	25	35
Ottawa loamy fine sand-----	40	60	30	50	25	35
Coloma fine sand-----	35	50	30	45	20	30

TABLE 8.—*Productivity ratings of soils in Cass County, Ind.*¹

Soil	Crop productivity						
	Corn (100 = 50 bu.)		Wheat (100 = 25 bu.)		Oats (100 = 50 bu.)		S (100 = 50 bu.)
	A	B	A	B	A	B	A
Newton loam (drained)-----	35	60	30	60	35	65	
Dillon fine sandy loam (drained)-----	30	55	30	50	30	55	
Newton fine sandy loam (drained)-----	30	55	30	50	30	60	
Plainfield fine sand-----	30	50	25	40	25	35	
Abington loam (undrained)-----	20	---	20	---	20	---	
Abington silty clay loam (undrained)-----	20	---	20	---	20	---	
Carlisle muck (undrained)-----	20	---	---	---	---	---	
Kokomo loam (undrained)-----	20	---	20	---	20	---	
Kokomo silty clay loam (undrained)-----	20	---	20	---	20	---	
Lear loam (undrained)-----	20	---	20	---	20	---	
Maumee fine sandy loam (undrained)-----	20	---	---	---	---	---	
Maumee loam (undrained)-----	20	---	---	---	---	---	
Millsdale silty clay loam (undrained)-----	20	---	20	---	20	---	
Nyona loam (undrained)-----	20	---	20	---	20	---	
Walkill silt loam (undrained)-----	20	---	---	---	---	---	
Washenaw silt loam (undrained)-----	20	---	20	---	20	---	
Dillon fine sandy loam (undrained)-----	---	---	---	---	---	---	
Fox loam, steep phase-----	---	---	---	---	---	---	
Newton fine sandy loam (undrained)-----	---	---	---	---	---	---	
Plainfield fine sand, rolling phase-----	---	---	---	---	---	---	
Limestone rockland-----	---	---	---	---	---	---	
Miami silt loam, steep phase-----	---	---	---	---	---	---	
Newton loam (undrained)-----	---	---	---	---	---	---	
Riverwash-----	---	---	---	---	---	---	

¹ Drained refers to artificial drainage; undrained to soils without artificial drainage.

The soils are listed in table 8 in the approximate order of their general physical suitability for the important crops of the present agriculture under prevailing management practices. The productivity ratings are based as far as possible on data obtained by experiment stations on similar soils, from records and experiments made by farmers in the county, and from similar sources. Where sufficient data are not available, the ratings are obtained by comparison with soils on which data are available, by field observations, and by consultation with farmers, county agricultural agents, and agricultural specialists.

MANAGEMENT OF THE SOILS OF CASS COUNTY ^{7a}

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Successful agriculture, requires, among other things, productive soils. Every farmer knows that soils differ in natural productivity. His particular farm may have good or poor soil or some of each. To make the most of his soil, a farmer should understand its characteristics and learn to correct its deficiencies. This is not difficult because the individual farm usually has only a few different kinds of soil. Each of these soils may present different problems in treatment and general management and must be studied and understood so that crops may be produced in the most satisfactory and profitable way.

The purpose of the following discussion is to call attention to the deficiencies of the several soils of the county and to outline the treatments most needed to yield satisfactory results. No system of soil management can be satisfactory unless it not only produces profitable returns but also maintains the productivity of the soil. By applying present-day knowledge, soils that can be farmed at all can be improved by properly balanced systems of treatment and crop management that will give sustained yields at satisfactory levels of production.

FERTILIZER ELEMENTS

The approximate content of nitrogen, phosphorus, and potassium in the principal types of soil in Cass County, expressed in pounds of elements in 2,000,000 pounds of surface soil per acre (6 to 7 inches deep), and the relative quantities of available phosphorus and potassium are shown in table 9. These data are based on the analyses of composite samples of each soil collected from several different fields. The basic information given in table 9 concerning the natural fertility status of the principal soils should be helpful in considering the quality of land in Cass County. In addition, an idea of some of the soil treatments that may be needed on certain soils may be obtained from the data in the table.

The total content of nitrogen generally is indicative of what need the soil has for nitrogen as well as for organic matter, since nitrogen and organic matter are closely associated. Usually the darker the soil the higher its nitrogen and organic-matter content. Soils having a

^{7a} Compiled in part by H. P. Ulrich, Department of Agronomy, Purdue University Agricultural Experiment Station. See also THE AGRONOMY HANDBOOK OF SOILS AND SOIL MANAGEMENT AND CROPS AND CROP PRODUCTION IN INDIANA, assembled and edited by Garnet H. Cutler and Merville O. Pence, Purdue University Agricultural Extension Service. Periodic revision is planned for this publication in order to keep it up to date.

low total nitrogen content soon become deficient in nitrogen, unless the supply is replenished by the growing and turning under of legumes or by the use of nitrogenous fertilizer.

TABLE 9.—*Approximate quantities of nitrogen, phosphorus, and potassium and relative quantities of available phosphorus and potassium in certain cultivated soils of Cass County, Ind.*

[Elements in 2,000,000 pounds of surface soil for an acre (6 to 7 inches deep)]

Soil type	Total nitrogen	Acid soluble phosphorus ¹	Total potassium	Available phosphorus	Available potassium
	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>		
Abington loam.....	6,600	1,410	25,000	Medium..	Low.
Abington silty clay loam.....	9,000	1,820	29,000	High.....	Medium.
Aubbeenaubee fine sandy loam.	2,200	510	20,000	Medium..	Low.
Bellefontaine fine sandy loam.	1,800	490	25,000	Low.....	Do.
Bellefontaine loam.....	2,600	540	31,000	do.....	Medium.
Berrien fine sandy loam.....	2,000	590	25,000	do.....	Low.
Bethel silt loam.....	2,400	690	28,000	do.....	Do.
Bronson fine sandy loam.....	1,800	380	21,000	do.....	Do.
Brookston loam.....	5,400	1,080	31,000	High.....	Medium.
Brookston silty clay loam.....	5,600	1,350	34,000	do.....	High.
Carlisle muck ²	22,000	1,150	6,000	Medium..	Low.
Carlisle silty muck ³	18,000	1,400	15,000	do.....	Do.
Coloma fine sand.....	1,200	660	16,000	Low.....	Do.
Coloma loamy fine sand.....	1,600	530	19,000	do.....	Do.
Conover fine sandy loam.....	2,800	670	20,000	Medium..	Do.
Conover loam.....	4,400	960	28,000	Low.....	Do.
Crosby fine sandy loam.....	2,000	420	18,000	do.....	Do.
Crosby loam.....	2,400	420	28,000	do.....	Do.
Crosby silt loam.....	2,600	590	32,000	do.....	Medium.
Dillon fine sandy loam.....	11,000	1,280	15,000	do.....	Low.
Eel loam.....	3,600	960	29,000	Medium..	Do.
Eel silt loam.....	4,000	1,270	27,000	do.....	Medium.
Fincastle silt loam.....	2,800	640	28,000	Low.....	Do.
Fox fine sandy loam.....	1,600	510	25,000	do.....	Low.
Deep phase.....	2,200	690	20,000	do.....	Do.
Fox loam.....	2,400	550	29,000	do.....	Medium.
Fox silt loam.....	3,600	940	29,000	do.....	Do.
Deep phase.....	3,600	1,020	31,000	do.....	Do.
Genesee fine sandy loam.....	2,200	800	2,800	do.....	Low.
Genesee loam.....	3,800	1,060	29,000	Medium..	Medium.
Genesee silt loam.....	4,200	1,530	30,000	do.....	Do.
Griffin fine sandy loam.....	4,400	1,000	21,000	Low.....	Low.
Hartman loam.....	3,000	730	22,000	do.....	Do.
Hartman silt loam.....	2,800	920	28,000	do.....	Do.
Homer fine sandy loam.....	2,000	530	24,000	do.....	Do.
Homer silt loam.....	2,800	630	27,000	do.....	Medium.
Kokomo loam.....	8,000	1,390	31,000	High.....	Do.
Kokomo silty clay loam.....	7,400	1,470	31,000	do.....	High.
Lear loam.....	7,600	1,060	23,000	Medium..	Low.
Maumee fine sandy loam.....	6,400	1,090	21,000	do.....	Do.
Maumee loam.....	11,000	1,470	25,000	do.....	Do.
Metea fine sandy loam.....	1,800	450	25,000	Low.....	Do.
Miami fine sandy loam.....	1,800	560	28,000	do.....	Do.

¹ Soluble in strong hydrochloric acid (specific gravity 1.115).

² Based on 1,000,000 pounds per acre.

³ Based on 1,500,000 pounds per acre.

TABLE 9.—*Approximate quantities of nitrogen, phosphorus, and potassium and relative quantities of available phosphorus and potassium in certain cultivated soils of Cass County, Ind.—Continued*

[Elements in 2,000,000 pounds of surface soil for an acre (6 to 7 inches deep)]

Soil type	Total nitrogen	Acid soluble phosphorus ¹	Total potassium	Available phosphorus	Available potassium
	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>		
Miami loam.....	2, 200	510	32, 000	Low.....	Low.
Miami silt loam.....	2, 800	690	32, 000	do.....	Medium.
Millsdale silty clay loam.....	5, 800	1, 550	30, 000	Medium..	Do.
Milton silt loam.....	3, 200	900	31, 000	Low.....	Do.
Newton fine sandy loam.....	5, 400	1, 040	20, 000	Medium..	Low.
Newton loam.....	5, 000	960	26, 000	Low.....	Do.
Nyona loam.....	6, 400	1, 020	24, 000	Medium..	Do.
Ottawa loamy fine sand.....	1, 400	440	24, 000	Low.....	Do.
Plainfield fine sand.....	1, 000	540	24, 000	do.....	Do.
Rolling phase.....	1, 000	490	24, 000	do.....	Do.
Russell silt loam.....	2, 800	750	33, 000	do.....	Medium.
Wallkill silt loam.....	8, 800	1, 470	41, 000	Medium..	Do.
Washtenaw silt loam.....	4, 600	1, 130	40, 000	do.....	Do.
Westland silty clay loam...	6, 000	1, 350	33, 000	High.....	Do.

¹ Soluble in strong hydrochloric acid (specific gravity 1.115).

The quantity of total phosphorus in most soils is usually about the same as that shown by a determination with strong acid, column 2, table 9. The supply of total phosphorus is low in most Indiana soils, and phosphatic fertilizers are generally needed.

The total quantity of potassium in the soil can seldom be taken as indicative of whether or not it needs potash fertilizer. Some Indiana soils that have more than 30,000 pounds of total potassium to the acre in the 6-inch surface layer fail to produce corn satisfactorily without potash fertilization because so little of the potassium is in an available form and the rate of release from the unavailable form is so slow. Sandy soils and muck soils more often need potash fertilization than clay and loam soils. Poorly drained soils and soils with impervious subsoils usually need it more than well-aerated soils that permit deep root penetration.

The available phosphorus and potassium determinations have been made by means of the so-called quick tests and the relative quantities are expressed as low, medium, and high. In interpreting these terms, it is usually assumed that soils testing low or very low will respond well to fertilization with the needed element. If the soil tests medium, a more limited response can be expected. A soil testing high or very high would be in no immediate need of the application of the plant food element concerned. Since the quick test is easily made, it is recommended that the soil or soils of each field of the farm be tested every few years to determine both the lime requirement and the fertility status. The available supply of any particular element may change because of the cropping system, the quantities of crops removed, the manure returned, and the fertilizer added. Plant tissue tests at critical periods in the development of the crop will show the nutrient status of the crop and which plant-food elements are most needed. A

soil testing service is provided at nominal cost through the Plant and Soil Laboratory, Purdue University, Agricultural Experiment Station, Lafayette, Indiana. Information on securing soil tests can be obtained by writing directly to the laboratory or by contacting the county agricultural agent.

The chemical data discussed in the foregoing paragraphs of this section are not intended to be the sole guide in determining the needs of the soil. It should be recognized that there are many other factors that affect crop production. The depth, the physical character of the horizons of the soil profile, and the previous treatment and management are of great importance and should be taken into consideration.

Tests indicate that nitrogen and phosphorus are much less available in subsurface soils and subsoils than they are in surface soils. On the other hand, potash in the subsoil seems to be of relatively high availability. Crop growth depends largely on the quantity of available plant nutrients that the roots come in contact with. Except on some soils of very low clay content and consequently very low fertility, such as Plainfield, the crop will grow well on a soil of relatively low analysis, if it can root deeply and thereby feed from a larger volume of soil. If the roots are shallow, the crop will suffer from lack of nutrients, particularly potash, even on a soil of higher analysis. Fine-textured soils with large quantities of nutrient elements and a high clay content can endure exhaustive cropping much longer than coarser textured soils of low clay content.

The nitrogen, phosphorus, and potassium contents of a soil are by no means the only chemical indications of high or low fertility. One of the most important factors in soil fertility is the base status and the degree of acidity of the soil. Soils that are strongly acid will not produce such crops as alfalfa, and sweet clover well, even though there is no lack of plant nutrients. Although nitrogen, phosphorus, and potassium are of some value when added to strongly acid soils, they will not produce their full effect until after such soils are limed.

The acidity is expressed as pH, or hydrogen-ion concentration. For example, pH 7 is neutral. If the pH value is more than 7, there is some lime, or other base, in excess. Soils testing between pH 6.6 and 6.1 are called slightly acid; between 6.0 and 5.6, medium acid; between 5.5 and 5.1, strongly acid; and below 5.0, very strongly acid. Wherever legumes are grown, particularly soil improving ones of high lime requirements, such as sweetclover and alfalfa, the soil should be tested to determine the reaction of both the surface soil and subsoil. In two soils having the same acidity in the surface soil, the one with the greater acidity in the subsurface layer is in greater need of lime. Those soils having a greater clay content than other soils of the same degree of acidity need a greater quantity of lime to neutralize them.

In interpreting the soil survey map and soil analyses, it should be kept in mind that a well-farmed and well-fertilized soil that is naturally low in fertility may produce larger crops than a poorly farmed soil naturally higher in fertility.

CROP ROTATION

Soil characteristics determine to a large extent suitable uses of the land. Some soils may be used successfully for continuous culture of intertilled crops, but there are some practical reasons why a proper

balance between intertilled crops, small grain, and grass-legume meadows will usually produce a greater long-time return than one-crop farming. Therefore, in selecting a rotation, due consideration should be given to certain guiding principles, particularly those critical factors that limit production on your farm. In selecting a rotation, it must be kept in mind that different crops have different nutrient requirements, feed in different depths of the soil, have different moisture requirements, and may produce either beneficial or harmful results on the soil. For example, intertilled crops cause organic matter to be used up rapidly, whereas meadow crops tend to enrich the organic content of the soil.

An adapted crop rotation properly managed (1) aides in maintaining the supply of nitrogen and organic matter, (2) helps control weeds, insects, and disease, (3) reduces soil erosion and leaching, (4) helps maintain crop yields, (5) makes use of manure and fertilizer more effectively, (6) provides better labor distribution, (7) permits diversity of income, (8) reduces the unit cost of production, and (9) fits in with livestock farming.

Below are 20 rotations listed in order from the most soil conserving to the most soil depleting. This list can be used for comparison of the different rotations as a guide in the selection of a suitable rotation for a given soil pattern.

No.	Rotation ¹	No.	Rotation ¹
1.	G-M-M-M	11.	C-B-G-M
2.	C-G-M-M-M	12.	C-B-G-M-C-G (Sc)
3.	C-G-M-M	13.	C-G (Sc)
4.	C-G-G-M-M	14.	C-C-B-G-M-M-C-O (Sc)
5.	C-G-M-M-C-G-G (Sc)	15.	C-C-G-M
6.	C-G-M-C-G (Sc)	16.	C-B-G (Sc)
7.	C-B-G-M-M	17.	C-C-G (Sc)
8.	C-C-G-M-M	18.	C-C-B-G-M
9.	C-G-M	19.	C-B
10.	C-G-G-M	20.	Continuous C

¹ Legend—C=corn; G=small grain; O=oats; B=soybeans; M=meadow; Sc=sweetclover.

MANAGEMENT GROUPS

For convenience in discussing their management, the soils of Cass County are arranged in table 10 by groups according to certain important characteristics that effect their use and require similarity in treatment. The main groupings are (1) light-colored mineral soils of uplands and terraces; (2) dark-colored mineral soils of uplands and terraces; (3) organic soils; and (4) soils of the bottom lands. For example, the light-colored mineral soils of uplands and terraces are generally acid in reaction and low in organic matter and nitrogen. The dark-colored mineral soils of the uplands and terraces and the soils of the bottom lands are usually neutral in reaction, rich in organic matter, and more fertile than those of the other groups. The organic soils discussed here are developed largely from decayed plant material; consequently they have very important fertility problems, such as excessive nitrogen supply and a very limited supply of potassium.

Within the general grouping here described, the soils have been placed in subgroups according to natural drainage conditions and other characteristics to bring out and emphasize specific management problems related to soil erosion, water supply for crop production, soil acidity and natural fertility, internal drainage, and overflow.

Where a given soil requires different treatment than that of the group, it is specifically pointed out in the table or text. In using this section, the reader should determine the kinds of soils from the map and their grouping and management characteristics from table 10, and then read the text for general principles applicable to the use of the group and for ways that a given soil may differ from members of the group.

Crop rotations recommended in table 10 are suitable for grain farming where the soil is level and fertile, or livestock farming where erosion or some other factor limits production. On sloping and erodible soils, conservation practices are recommended as necessary. To use successfully the recommended rotation, it will be necessary to lime and fertilize adequately and follow other good agronomic practices in order to grow the crops indicated. Where more than one rotation is given, the first is the more conserving. If desired, another rotation may be selected from the list on page 97. To provide adequate protection, however, the rotation will need to be more conserving (that is, higher on the list) than the top rotation in table 10.

MANAGEMENT GROUP 1—WELL-DRAINED MEDIUM-TEXTURED SOILS

Soils of management group 1 have been subdivided on the basis of slope and problems related to land use into subgroups as follows: 1A—Soils with gentle slopes (2 to 6 percent); 1B—Soils with moderate slopes (8 to 20 percent); 1C—Soils with steep slopes (20 to 50 percent) and 1D—Soils shallow to bedrock. Soils of the first two subgroups are arable and suited to the kinds of farming common in the county. Nonarable soils in this group include the shallow soil, Farmington silt loam and Limestone rockland. The soils of management group 1 occupy about 44,000 acres, or about 16.5 percent of the total area of the county. Specific management suggestions are given in table 10 for each of the management subgroups.

MANAGEMENT SUBGROUP 1A—SOILS WITH GENTLE SLOPES

Management subgroup 1A includes Miami loam, Miami silt loam, Russell silt loam, Russell-Miami silt loams, and Milton silt loam. With proper fertilization and liming, these soils will produce satisfactorily all the crops adapted to the locality.

Drainage and erosion control.—These soils not only have good natural drainage but excessive runoff on the sloping areas. Under cultivation, particularly with intertilled crops, they are susceptible to erosion. The amount of erosion depends (1) on the ability of the soil to take up water and remove it quickly through the soil and (2) on the length and the steepness of the slope. Increasing the organic content by use of manure, crop residues, cover crops, and green manure crops will improve tilth and the moisture uptake as well as increase the moisture supply for crop production.

Erosion is the most serious problem on this group of soils. Serious soil loss probably has occurred on all the more sloping areas that have been under cultivation. In the advanced stages of erosion, the plowing up of the more clayey subsoil reduces the rate of moisture intake and accelerates the soil loss.

In order to control erosion natural water courses should be graded and kept in a grass cover wide enough to allow water to spread. Wherever possible, particularly where slopes are in one direction, plowing and other tillage operations should be crosswise of the slope

so that the speed of runoff is reduced and the formation of rills and gullies prevented. Where slopes are in several directions, as they often are on knolls on the divides, contour tillage may not be feasible. Under such conditions erosion can be controlled by reducing the proportion of row crops and keeping the soil in small grain and meadow crops a large part of the time.

Liming.—In their natural state, most light-colored soils of the uplands and terraces were medium acid in reaction. Where erosion is active, as on steep slopes, and where the soils (such as Milton and Farmington) are younger and less well developed, the soil may be slightly acid to neutral and require little or no lime. For most legumes the soil should be limed to pH 6.5. As most soils have been limed to some extent, the soils should be tested, particularly if any trouble has been experienced in growing legumes. Farmers who cannot make the test can have it made at nominal cost through the Plant and Soil Laboratory, Agricultural Experiment Station, Purdue University, Lafayette, Ind.

Organic matter and nitrogen.—All the soils of this group are naturally low in organic matter and nitrogen—generally the lighter the color of the soil, the lower the content. Constant cropping, without adequate return of organic matter to the soil, and various degrees of soil erosion are steadily depleting these important constituents. In many places the original supplies of organic matter have become so reduced that the soil has lost much of its native mellowness and easily becomes puddled and baked. This condition accounts in a large measure for the more frequent failure of clover and the greater difficulty of obtaining proper soil tilth.

Wherever evidences of lack of organic matter occur, the only practical remedy is to plow under or otherwise incorporate into the soil more organic matter than is used up in the processes of cropping. Decomposition of organic matter is constantly going on in the soil. Decomposing organic matter should supply a substantial portion of the nitrogen required by crops. Since legumes are the only crops that can add appreciable quantities of nitrogen, along with organic matter, to the soil, they should be utilized as fully as practicable in the cropping system. Crops fed to livestock should be returned to the soil in the form of manure, and all crop residues not so utilized should be incorporated directly into the soil. Cornstalks, clover and soybean haulm, and straw should never be burned. Burning destroys organic matter and drives the nitrogen back into the air. Modern plows equipped with trash shields will turn down and completely cover cornstalks and other heavy growth.

A good way to increase organic matter and conserve nitrogen is to seed rye as a cover crop in August or early in September on cornland that is to be plowed the following spring. Sweetclover and ryegrass may also be seeded in corn at the last cultivation. It is important to have some kind of a growing crop on these soils in fall and winter in order to take up soluble nitrogen that otherwise would be lost through leaching and to reduce runoff and erosion. Without living crop roots to take up the nitrates from the soil water, large losses may occur between the regular summer-crop seasons and erosion on slopes and hillsides will be greater.

Crop rotation.—Because of the erosion hazard, the soils of subgroup 1A are better suited to a grain-livestock system of farming in which a 4-year rotation of corn, small grain, and 2 years of mixed meadow is

recommended where conservation practices are not followed. On more sloping and erodible areas, the proportion of row crops to meadow crops in the rotation may have to be decreased. Because of the prevailing shortage of nitrogen and organic matter and occasional meadow failures due to inadequate liming or unfavorable weather conditions, mixed grass-legume seedings should be made rather than pure stands of red clover or alfalfa. Where meadows stand either 1 or 2 years, a satisfactory mixture consists of 3 or 4 pounds each of red clover and hardy alfalfa, $\frac{1}{4}$ pound of Ladino clover, and 2 to 3 pounds of timothy per acre. This seeding is suitable for either hay or pasture.

For fertile soils that have been limed and fertilized adequately, alfalfa should be the principal legume in the mixture, especially for meadow periods of 2 years or longer. The following mixture is recommended: Alfalfa, 8 pounds, smooth brome grass, southern strain, 2 to 4 pounds, timothy 2 pounds if fall sown and up to 6 pounds if spring sown, and $\frac{1}{2}$ pound of Ladino if the crop is used for hay or pasture. Brome grass is more productive and also more drought resistant than timothy but it becomes established more slowly the first year after seeding.

Corn, soybeans, wheat or oats, and mixed hay constitute an excellent 4-year rotation for these soils. Although both corn and soybeans are well adapted, two clean-tilled crops should not be grown in succession where erosion is a hazard and no method of control is followed. The two legumes in this rotation will build up the nitrogen supply of the soil if considerable portions of the produce are left on the ground or returned, either directly or in the form of manure. With modern combines, the soybean straw can be spread evenly on the ground, and it will not interfere with the seeding of wheat. When soybeans are first introduced, the seed should be carefully inoculated with the proper variety of nitrogen-gathering bacteria, and this inoculation should be applied at least 2 years in succession. If more corn is wanted, as on intensive livestock farms, corn may be substituted for soybeans in the above rotation. On level nonerodible areas where the second corn crop can be given a good dressing of manure or nitrogen fertilizer, the 5-year rotation of corn, wheat or oats, and mixed hay for 2 years may be used satisfactorily. Where enough livestock is kept to utilize all feed grain and roughage in this rotation, there should be enough manure produced to make a fair application for each corn crop. In both the 4-year and 5-year rotations, a winter cover crop of rye should be seeded in the corn in September and plowed under with the corn residues the following spring.

Alfalfa and sweetclover may be also grown alone on most of these soils if limed where needed and properly inoculated with nitrogen-gathering bacteria. In situations favorable to alfalfa, a separate field of alfalfa has been found to be a good insurance against shortage of hay or pasture.

Fertilization.—The soils of management subgroup 1A are naturally low in phosphorus. The available supplies of this element are generally so low that the phosphorus required by the crops must be wholly supplied in applications of manure and commercial fertilizers. The nitrogen supplies in these light-colored soils are also too low to meet satisfactorily the needs of corn, wheat, oats, and other non-leguminous crops, and provisions for adding nitrogen must be made in the soil-improvement and crop-fertilization program. The total

quantities of potassium in these soils are large, but in most of the cultivated acreage the available supplies have become so reduced that potash, in manure or commercial fertilizer, must be applied for the most satisfactory production of crops. Without substantial provision for supplying all three of these fertilizer elements, the productivity of these soils will remain relatively low.

Legumes and manure are the logical materials for supplying the greater part of the nitrogen required by crops, and they should be employed to the fullest practicable extent. Livestock farming that includes a liberal proportion of legumes in the cropping system is best for these soils. In most cases more nitrogen will be required for the grain crops, especially wheat and corn, than the manure and legumes produced will supply. It will pay to have some nitrogen in the fertilizer for wheat, regardless of its place in the rotation. Though it follows soybeans, wheat should be started properly by using nitrogen in the fertilizer applied at seeding time, because the nitrogen in the soybean residues does not become available quickly enough to be of much help in fall. The residues must decay first, and decay does not take place to any considerable extent until the following spring. Where a good clover or other legume sod is not available to supply the corn crop with nitrogen and little or no manure is applied, it pays to plow under 40 to 80 pounds an acre of elemental nitrogen, (the amount contained in 120 to 240 pounds of ammonium nitrate or 300 to 400 pounds of ammonium sulphate or cyanamide) along with liberal quantities of phosphate and potash. Urea, anhydrous ammonia, or other forms of nitrogen may also be used.

The only practical way to increase the supply of phosphorus in the soil is through the application of phosphatic fertilizers. Since large quantities of the phosphates applied are fixed by the soil in forms not immediately available, much larger quantities than the crop actually needs should be used. Manure, of course, should be used to the fullest practicable extent. It must be remembered, however, that manure returns to the soil only a part of the phosphorus taken out by the crops from which it was made and so adds nothing to the original supply.

Manure unleached by rain supplies about 10 pounds of potash per ton. The rest of the needed potash not supplied by the soil must be provided in commercial fertilizer. Only a small part of the large total supply of potash becomes available for crop use during a single season. The availability of the soil potash may be increased by good farming practices, including drainage where needed, deep tillage, the growing of deep-rooted legumes, and the plowing under of liberal quantities of organic matter.

In the practical fertilization of these soils, most of the manure should be plowed under for the corn crop. Where the crop rotation includes wheat, some of the manure, about 2 tons to the acre, may be applied profitably to this crop as a topdressing in winter.

The commercial fertilizer recommendation in table 10 is listed under two management levels: (1) Average management for the farmer who desires to make a smaller investment in fertilizers and (2) superior management for the farmer who wants to build up the phosphate-potash reserve and at the same time maintain a medium or higher level of yield. The recommendations are given as pounds of P_2O_5 and K_2O per acre per year based on the recommended crop rotation on soils

that test medium or high in phosphate and potash. Where tests indicate that the soil is low in fertility and corn yields would be low without more fertilizer, it will usually pay to plow down 500 to 1,000 pounds an acre of 10-10-10 or a higher analysis fertilizer and to make a light hill or row application of 3-12-12. Such applications have been profitable on medium-textured light-colored soils but involve greater risk on soils that have low water supplying power.

For the Miami group of soils on 2 to 6 percent slopes a 4-year rotation of corn, small grain, and 2 years of mixed grass-legume meadow is recommended. Under average management for soils of subgroup 1A, 20 pounds of P_2O_5 and 20 pounds of K_2O are recommended per year; therefore 80 pounds of each would be applied over the 4-year period. If 200 pounds of 3-12-12 per acre is applied to corn in the row and 400 pounds is drilled with the small grain, there would be a deficit of 8 pounds of each for the rotation, or the equivalent of 66 pounds of 3-12-12. Under either system of fertilization, when the difference between the amounts needed and the amounts put on the grain is large enough, it would be applied as a broadcast application, either after the first cutting of second year meadows or before plowing for corn. Otherwise, a small deficit such as in the above example would be made up either by a change in the analysis or by an increase in the rate applied to grain crops.

Supplementary applications of nitrogen, either plowed down or sidedressed for corn, are recommended where corn follows corn or a poor legume sod. A topdressing of 20 pounds or more per acre of elemental nitrogen to the wheat soon after growth starts in the spring will usually produce an increase in yield of 3 bushels or more per acre. This is the amount of nitrogen contained in about 60 pounds of ammonium nitrate or 100 pounds of ammonium sulphate. Oats are not as responsive to fertilizer as wheat, but where they are followed by meadow, they should also receive 300 to 400 pounds of 3-12-12 per acre. On light-colored soils from 20 to 40 pounds of nitrogen per acre may be applied without causing excessive shading of the meadow mixture by the grain crop. A bushel increase per acre in yield should be expected for each 3 or 4 pounds of nitrogen so applied.⁸

⁸ The fertilizer recommendations given in table 10 show the pounds of nitrogen (N), available phosphorus (P_2O_5), and water-soluble potash (K_2O) per acre required annually for rotations listed for the management group or subgroup.

Below is a sample calculation of a fertilizer program for a given field of Miami silt loam under superior management and with a rotation of corn, wheat, and meadow for 2 years.

	N	P_2O_5	K_2O
Annual need.....	0	25	40
Total need during 4-year rotations, 4 times (0-25-40).....	0	100	160
Apply:			
200 pounds of 3-12-12 to corn.....	6	24	24
400 pounds of 3-12-12 to wheat.....	12	48	48
	18	72	72
Additional P_2O_5 and K_2O needed.....		28	88
Broadcast application of 300 pounds of 0-9-27 to meadow would supply approximately the additional need.....		27	81
Additional nitrogen is not recommended for corn when it follows 2 or more years of a good legume-grass meadow.			

Where soybeans follow corn, they may be best fertilized by making a heavier application to the preceding corn crop, as they are sensitive to fertilizer injury during germination and early growth. Approximately 100 pounds of 0-12-12 or 0-10-20 per acre may be safely drilled beside the row with the beans.

Alfalfa is well adapted to all the soils of this group after they are limed adequately as needed. If liberally fertilized with phosphate and potash, alfalfa will prove profitable for either hay or pasture. Mixed seeding with small grain is the more common practice. For single seeding, 300 to 400 pounds per acre of 0-12-12 or similar fertilizer should be applied, either with a light seeding of oats in the spring or by itself on specially prepared ground sometime in August after a good rain. To maintain good yields and prolong the life of the stand, a topdressing of at least 300 pounds an acre of 0-10-20 or similar fertilizer should be applied every other spring.

MANAGEMENT SUBGROUP 1B—SOILS WITH MODERATE SLOPES

The soils of subgroup 1B are Miami silt loam, sloping phase; Russell silt loam, sloping phase; and Russell-Miami silt loams, sloping phases. They occur on slopes ranging from 8 to 20 percent. Most of these soils are or have been under cultivation. As they usually occur in small areas, they are often cropped with the same intensity as associated soils. Because of the slope and the greater susceptibility to erosion, cultural problems are similar to those of the associated soils, but control methods must be applied more intensively to preserve the soil. On areas with a serious erosion hazard, the use of a 4-year rotation of wheat and 3 years of an alfalfa-grass meadow mixture can control erosion (see alfalfa-bromegrass mixture previously recommended on page 100). This rotation can be conveniently used by letting the many small areas lie in meadow a third year instead of plowing them for corn. Where these soils occur along drainageways, they are usually somewhat steeper and slope in only one direction; consequently conservation practices such as contour tillage can be readily applied. Without such practices it is necessary to keep a vegetative cover on the soil most of the time.

Much of this sloping and eroded land has reverted to permanent pasture largely because of the declining crop yields. On such areas the grass stand is often thin and weedy and has low carrying capacity for stock. The productivity of such areas can be greatly increased by pasture renovation. Their need for lime and fertilizer can be determined by soil testing. Usually an application of 1 to 2 tons of lime is needed and 300 to 500 pounds of superphosphate or 0-20-10 per acre. These applications should be broadcast and disked into the ground. A suitable pasture mixture for reseeding consists of legumes and grasses, including birdsfoot trefoil, Ladino clover, bromegrass, timothy, and Kentucky bluegrass. The fertilizer treatment should be repeated every 3 to 4 years.

MANAGEMENT SUBGROUP 1C—SOILS WITH STEEP SLOPES

Management subgroup 1C is composed of the steep phases (slopes 20 to 50 percent or more) of the Russell and Miami series and Fox loam, steep phase. Because of slope, erosion, and low productivity they are generally unsuited to cropping. The best use of these soils is permanent pasture. If they are forested it is suggested they remain in forest.

MANAGEMENT SUBGROUP 1D—SOILS SHALLOW TO BEDROCK

Farmington silt loam, and the associated Limestone rockland, are in this management subgroup. Much of the area of these soils has not been cleared of timber, but permanent bluegrass pasture is probably the principal use. Many areas having very low livestock-carrying capacity would respond to pasture renovation where the stand is thin and the land is not too steep. Most of this land is nearly neutral in reaction and not in need of lime. Use has been limited by soil erosion, low fertility, overgrazing, and lack of weed control.

MANAGEMENT GROUP 2—MODERATELY WELL DRAINED TO SOMEWHAT EXCESSIVELY DRAINED MEDIUM AND MODERATELY COARSE TEXTURED SOILS

Soils of management group 2 have been subdivided on the bases of slope and texture into: 2A—nearly level medium-textured soils; 2B—nearly level moderately coarse textured soils; and 2C—moderately sloping medium and moderately coarse textured soils. The total acreage of the soils of this group in Cass County is about 54,300 acres or 20.4 percent of the county.

Specific management practices for each management subgroup are given in table 10.

MANAGEMENT SUBGROUP 2A—NEARLY LEVEL MEDIUM-TEXTURED SOILS

Management subgroup 2A includes Fox silt loam, deep phase; Fox silt loam; Fox loam; Hartman silt loam; and Hartman loam. With this and the following excessively drained groups of soils that are developed from gravelly or sandy materials, the most important single problem of land use is moisture-supplying power for crop production.

Drainage and erosion control.—Soils of management subgroup 2A have good to excessive natural drainage. Except on gentle slopes around kettle holes and the heads of short drainageways, there is little runoff. Loss of drainage water and erosion are not serious problems. Water moves slowly over the nearly level land and is quickly taken up by the surface soil. Because of the porous substratum, water moves through the soil rather rapidly, but the moisture-supplying power for crop production is closely related to the thickness of the soil over gravel and to the clay content of the soil. Other than erosion, soil management problems are somewhat similar to those of management group 1 (well-drained silt loam and loam soils) except that constant attention should be given to improving their water-holding capacity by incorporating as much organic material as possible, including manure, crop residues, cover crops, and especially green manure crops.

Erosion control is most readily effected by keeping the soil covered with vegetation throughout most of the year. The Fox soils usually have simple or one-direction slopes around drainageways that lend themselves readily to mechanical practices such as contour tillage.

Liming.—The acidity of this group of soils is partially related to the height of terraces above the flood plain and to the age, or stage of development, of the soils. The lime requirement generally ranges from 1 to 2 tons per acre, but soils of the higher terrace positions, particularly Fox silt loam, deep phase, are usually the more acid, while those of the low terraces, such as the Hartman soils, are nearly neutral in reaction and probably require no lime even for such crops as sweet-clover.

Organic matter and nitrogen.—During prolonged periods of dry weather, the moisture problem on this group of soils is likely to become more acute than on similar textured soils of the uplands, such as those of the Miami group. Building up the organic-matter content and moisture-holding capacity and use of more drought-resistant crops such as alfalfa, soybeans, and wheat will help to offset the effects of summer drought. Oats yields are invariably reduced somewhat by the hot dry weather that usually comes during June.

Crop rotation.—A 5-year rotation of corn, soybeans, wheat, and an alfalfa-bromegrass mixture for 2 years will provide well-adapted crops and a maximum of drought resistance on this group of soils. Corn is susceptible to drought damage during prolonged dry periods on any soil of the group, but the danger is greater on Fox loam and the Hartman soils. Alfalfa, either in pure stand or a mixture, is well suited because of its deep rooting. Smooth bromegrass is more drought-resistant than timothy, which is usually recommended for meadows standing 2 years or less.

Where the slopes are gently sloping and somewhat erosive, contour tillage should be practiced where feasible; otherwise a small grain, preferably wheat, may be substituted for soybeans to control erosion.

Fertilization.—Because of the drought hazard, attention should be given to building up the general level of fertility and increasing the organic-matter content and moisture-holding capacity rather than to very heavy fertilization unaccompanied by measures to increase organic matter. Provision for maintenance of organic matter is particularly needed on Fox loam and Hartman soils. Plowing down heavy applications of fertilizer for corn may not be successful in abnormally dry years. For pure stands of alfalfa and mixed stands retained more than 2 years, yields may be maintained and the life of the stand prolonged by topdressing with a fertilizer high in potash during the second year after the first cutting of hay.

MANAGEMENT SUBGROUP 2B—NEARLY LEVEL MODERATELY
COARSE TEXTURED SOILS

Management subgroup 2B includes the Fox and Bronson fine sandy loams of the terrace positions.

This group of soils is intermediate between the soils of management subgroup 2A and the loose sandy soils of management subgroup 3A. Because of the better aerated and more open texture of this group, fertility problems related to phosphorus, potash, and nitrogen, together with the organic-matter content and the moisture-supplying capacity, are more serious than on the previously discussed group. None of the soils of group 2B contain enough phosphorus or potassium to warrant cropping without liberal fertilization, but the moisture supply where the soils are adequately fertilized is likely to be the limiting factor in crop production. Like the previously discussed group, these soils are acid and need lime for the satisfactory production of otherwise well-adapted legumes.

Drainage.—As a group these sandy soils are so loose or open-textured to considerable depths that natural drainage is excessive and droughtiness is a common fault. Only the Bronson fine sandy loam, bordering dark-colored depressional soils, is likely to become waterlogged during wet spring weather. The Fox fine sandy loam soils occupy slightly

higher, nearly level terrace positions; consequently most of the surface water is absorbed with little runoff or erosion except on gentle slopes around kettle holes and short drainageways. Soils of this group that occur on upland positions are generally sloping and moderately erosive.

Liming.—These light-colored sandy soils all have some acidity, and legumes such as alfalfa and sweetclover usually require liming if they are to grow successfully.

Organic matter and nitrogen.—The organic-matter content of this group is very low because of the open well-aerated condition favoring rapid decomposition and oxidation of the soil organic matter and because of the low clay content. Since the moisture-supplying power of these soils is very low, building up the organic-matter content and improving the water-holding capacity require constant attention. The proportion of row crops that deplete organic matter should be limited in the rotation, and the soil should always be kept covered with a growing crop to take up soluble plant nutrients and so reduce losses from leaching. An adequate vegetative cover is also effective in reducing both water and wind erosion. Because of the moderate acidity and fair fertility of these soils, soil-building deep-rooted legumes such as sweetclover and alfalfa can be readily grown and should have an important place in the cropping system.

Crop rotation.—A 5-year rotation of corn, wheat, and mixed alfalfa-bromegrass for 3 years is probably the most satisfactory for improving the soils of group 2B and effectively using the limited moisture supply. It controls erosion on the sloping areas and has a limited proportion of row crops to deplete the organic-matter supply. On nearly level areas of less droughty soils such as Fox fine sandy loam, deep phase, a 6-year rotation of corn, soybeans, wheat, and alfalfa-bromegrass meadow for 3 years probably will satisfactorily maintain crop yields and be more profitable.

Fertilization.—In the fertilization of these fine sandy loam soils, the maximum use should be made of legumes to provide nitrogen. Manure should be utilized to the fullest possible extent, and all crop residues should go back to the land. Additional nitrogen supplies will be needed for the grain crops, especially wheat. Available supplies of both phosphate and potash are very low in these soils, and adequate quantities should be supplied. However, the droughtiness of these soils and their tendency to leach limit the quantities of fertilizer than can be safely applied at one time. Nitrogen and potash are most likely to be lost by leaching and should therefore be applied in quantities that can be used by the crop during the growing season. In general, the return of manure to the soil will in part supply the potash needs, but all the phosphorus will have to be supplied in commercial fertilizer.

Since corn is not well suited to light-colored sandy soils, it should always follow a good legume sod crop that has been manured wherever possible. At planting time 150 to 200 pounds of 3-12-12 or 3-9-18 fertilizer per acre should be drilled with the corn. If adequate moisture supplies are expected, supplementary nitrogen may be plowed down or applied as a sidedressing. Wheat should always receive a top-dressing of about 20 pounds per acre of soluble nitrogen early in the spring. Alfalfa is better adapted than most crops to these soils because of its deep-rooting and drought-resisting qualities, but

liberal fertilization, particularly with potash, is required to maintain a thick and lasting stand. As permanent pastures are not dependable, drought-resisting rotation meadows should be the chief source of both hay and pasture.

MANAGEMENT SUBGROUP 2C—MODERATELY SLOPING MEDIUM AND
MODERATELY COARSE TEXTURED SOILS

The soils of management subgroup 2C are Bellefontaine loam, Bellefontaine fine sandy loam, Miami fine sandy loam, and Metea fine sandy loam. Like those of subgroup 2B, these soils are naturally low in fertility and organic matter. To obtain satisfactory yields, fertilizers containing nitrogen, phosphorus, and potash are necessary. Moisture-supplying capacity is low, and deep-rooted crops or crops that grow during the cool seasons are least likely to suffer drought injury.

Management of these soils is very similar to that of subgroup 2B. The main difference is that on the more sloping soils of this group soybeans usually should not be included in the rotation.

MANAGEMENT GROUP 3—EXCESSIVELY DRAINED COARSE TEXTURED SOILS

Composed of the Coloma, Ottawa, and Plainfield loamy fine sands and Coloma and Plainfield fine sands, management group 3 includes soils of very low moisture-supplying power for crop production and very low fertility. On exposed sites where the organic content is very low, wind erosion is likely to be serious. Management problems dealing with the moisture supply and fertility are very critical for these soils. Consequently they have limited use for moderately adapted special crops and general farm crops. Eroded areas, such as blowouts and some of the more infertile areas of Plainfield, are better suited to forestry.

Soils of this group occupy about 12,300 acres or 4.7 percent of the county.

Drainage.—Both surface soil and subsoil drainage are very rapid through these deep loose sandy soils. The topography is irregular and dunelike on much of this group; consequently, where there is no timber or vegetative cover, wind erosion is a hazard, especially on the exposed high points.

Liming.—These soils are all acid and require adequate liming in order to grow deep-rooted legumes, such as alfalfa and sweetclover, which are so essential in the cropping program on this management group. The Coloma soils are usually less acid than the other soils of this group. Alfalfa therefore can be more successfully grown on them, as its deep roots can usually reach the nonacid calcium-bearing soil that occurs within 4 to 5 feet.

Organic matter and nitrogen.—As these soils are droughty and very low in organic matter, they should be put in condition to grow the more efficient nitrogen-gathering and drought-resisting legumes such as alfalfa and sweetclover. The cropping system should be made up mainly of small grains and meadow crops. Constant attention should be given to maintaining the organic matter and nitrogen content at satisfactory levels and to providing an adequate winter vegetative cover to prevent leaching of plant nutrients or blowing of the surface soil.

Crop rotation.—Oats, corn, and to some extent soybeans are unsuited because of the low moisture-supplying power of these soils. Rye and wheat that mature before the hot, dry summer months and deep-rooted crops such as alfalfa are best suited. Rye can be grown continuously if adequately fertilized, especially with nitrogen. However, a 4-year rotation consisting of rye or wheat and 3 years of alfalfa will probably be most successful in providing roughage and feed in a livestock system of farming so essential on these soils.

Alfalfa will stand a lot of drought, and if sufficiently limed and fertilized with phosphate and potash, it will produce more than any other hay or pasture crop. On the Sand Experiment Field (Plainfield fine sand) near Culver, the most successful stands of alfalfa have been obtained from late-July or early-August seedings on disked small-grain stubble land. Some growers on these droughty soils favor plowing late in spring, summer fallowing late in July or early in August, and then lightly drilling the alfalfa seed with some fertilizer on a well-cultipacked surface. Extra phosphate and potash should be plowed under or drilled in before the final preparation of the land for seeding.

Where markets are accessible and there is adequate volume of produce, some of these sandy soils, such as Coloma, may be suited to melons, berries of various kinds, peaches, and grapes.

Fertilization.—In the fertilization of these sandy soils, legumes and manure should be used to the fullest possible extent to supply organic matter and nitrogen. Phosphate and potash are in very short supply and should be liberally used. Potash is particularly needed in the culture of alfalfa to retain a thick and long-lived stand. Broadcast application is recommended; it should be applied after the first cutting as a topdressing to the second-year alfalfa meadows. Where available, manure should be used as a topdressing early in the winter on the small grain, and followed by a broadcast application of 20 to 30 pounds of soluble nitrogen early in the spring when growth starts.

MANAGEMENT GROUP 4—MODERATELY WELL DRAINED COARSE AND MODERATELY COARSE TEXTURED SOILS

Management group 4 is composed of Berrien fine sandy loam and Berrien loamy fine sand. Their total acreage is small, only about 1,608 acres or 0.6 percent of the county.

Drainage.—The low-lying position of these soils and periodic high water table distinguish them from the soils of management group 3. When the water table recedes during summer, available moisture supplies may be inadequate for satisfactory crop production. Alfalfa is poorly suited because of the high water table during wet periods.

Liming.—The lime need is usually high—higher than would normally be expected for soils of these textures.

Fertilization and organic matter.—Farm manures and crop residues should be used regularly on these soils to supply organic matter and nitrogen. Nitrogen from these sources is available over a longer period than soluble chemical nitrogen supplied by fertilizers. This is especially important in sandy soils such as these that have little clay to hold plant nutrients.

Small fruits, as strawberries and the brambles, are adapted but need heavy applications of a complete fertilizer.

**MANAGEMENT GROUP 5—IMPERFECTLY DRAINED MEDIUM
AND MODERATELY COARSE-TEXTURED SOILS**

Management group 5 consists of the imperfectly drained soils of the uplands and is divided into two subgroups of different textures. They are: 5A—medium-textured soils and 5B—moderately coarse-textured soils. Together they occupy about 43,900 acres, or 16.5 percent of the county.

Management suggestions for the subgroups are given in table 10.

MANAGEMENT SUBGROUP 5A—MEDIUM-TEXTURED SOILS

Management subgroup 5A consists of Conover loam, Crosby loam, Crosby silt loam, Fincastle silt loam, Fincastle-Crosby silt loams, and Homer silt loam. The Crosby and Fincastle silt loams greatly predominate. Conover loam is intermediate in drainage and color between the other members of this group and the dark-colored very poorly drained soils of management group 7. It is moderately dark in color and nearly neutral in reaction. It was placed in this group because its drainage characteristics are more nearly like those of Crosby and Fincastle soils.

Drainage.—These soils were all developed under conditions of imperfect drainage. Their flat or only slightly sloping topography and relatively heavy and tight subsoils make them naturally wet and in need of artificial drainage. Homer silt loam has a gravelly substratum, but it is usually at too great a depth to help drainage. The need for better drainage on these soils has been recognized by farmers and on many areas some tile underdrainage has been provided. Where tiling is still needed, the tile lines should be laid 30 to 40 inches deep and spaced about 3 rods apart. Wherever there is a gray or gray and yellow mottled subsoil, insufficient drainage is indicated. Without tile underdrainage such soils cannot be satisfactorily managed and other beneficial soil treatments cannot produce their full effect. Tile drainage facilitates soil aeration, permitting deeper penetration of oxygen that helps to make the plant nutrients in the soil more available. Tile drainage also permits plants to develop stronger and more efficient root systems that absorb required nutrients. Heavy fertilization may be of no avail if healthy root growth is hindered because excess water in the soil shuts out needed oxygen.

Where land to be tiled is flat, great care must be exercised in order that the tile lines may have an even or accelerated fall. Nothing less accurate than a surveyor's instrument should be used in establishing grades. The grade stakes on the individual lines should be set carefully before the ditches are dug and checked afterwards to make sure that the water will flow to the outlet with no interruption or slackening of the current. The rate of fall may be increased towards the outlet; but it should never be decreased without inserting a silt well or settling basin, as checking the current may cause the tile to become choked with silt. It is an excellent plan, before filling the ditches, to cover the tile to a depth of a few inches with straw, weeds, or grass. This prevents silt from washing into the tile at the joints while the ground is settling and thus insures proper operation of the drains from the outset.

Liming.—Crosby and Homer soils range from slightly to medium acid and should receive 1 to 2 tons of ground limestone an acre. Fincastle silt loam is strongly acid, and, as a rule, should receive 2 to 3 tons of ground limestone an acre, or its equivalent in some other form of

lime. Whenever there is doubt concerning the lime requirement, the soil should be tested for acidity.

Organic matter and nitrogen.—Like the associated well-drained, light-colored silt loam and loam soils, these soils are low in organic matter and nitrogen. These inadequately drained soils with low organic-matter content tend to flow together and puddle readily when wet and to crust over when dry. There is consequently greater difficulty in securing a satisfactory physical condition for seeding crops. Adequate drainage combined with the building up of the organic-matter supply will do much to restore the original mellow tilth of these soils.

Crop rotation.—With proper liming, drainage, and fertilization, these soils will produce satisfactorily all the ordinary crops adapted to the locality. Because of the prevailing shortage of nitrogen and organic matter, every system of cropping or crop rotation should include one or more legumes to be returned to the land in one form or another.

A 4-year rotation of corn, soybeans, wheat or oats, and mixed grass-legume meadow is recommended for this subgroup, because the crops are well adapted and soil erosion is not a problem. This rotation is preferred to the old standard 3-year rotation of corn, small grain, and hay, because it greatly simplifies the disposal of corn-crop residues, which can be turned under completely when plowing the land for the soybean crop, and because it provides for timely and easy seeding of wheat. Other advantages of this 4-year rotation have been discussed for the well-drained, light-colored mineral soils of uplands and terraces, with gentle slopes (management subgroup 1A).

If more corn is wanted than the 4-year rotation will provide and the fertility of the soil has been increased satisfactorily, a 5-year rotation of corn, corn, wheat or oats, and clover or mixed hay for 2 years may be used. This rotation, however, requires normal quantities of manure supplemented with commercial fertilizer to maintain a proper fertility balance. It is well adapted to livestock farms where all the feed grains and much of the roughage can be profitably utilized and the resulting manure applied to the two corn crops.

Fertilization.—The soils of this group are similar to the well-drained, light-colored mineral soils of uplands and terraces, with gentle slopes (management subgroup 1A), in their natural supplies of nitrogen, phosphorus, and potassium, and their fertilization requirements are similar to those discussed for these soils. The soils of subgroup 5A, however, may be more deficient in available potash because of restrictions on root development by seasonally excessive moisture supplies and by the rather heavy compact subsoil. For these reasons the fertilizer for these soils should contain more potash than that for the brown or yellowish soils. The availability of the soil potash may be increased by good farm practices, including tile drainage, proper tillage, the growing of deep-rooted legumes, and the plowing under of liberal quantities of decomposable organic matter to facilitate oxidation.

MANAGEMENT SUBGROUP 5B—MODERATELY COARSE TEXTURED SOILS

Soils of management subgroup 5B, include the fine sandy loams of the Aubbeenaubbee, Conover, Crosby, and Homer series. The Conover soil included here is moderately dark colored and somewhat more

productive, particularly for corn, than the other members, but it occurs in relatively small areas mixed with and usually farmed like the associated Crosby soil. Otherwise these soils are all naturally low in total content of organic matter, nitrogen, and phosphorus. None of them contain enough available phosphorus or potash to warrant cropping without liberal fertilization. Most of them are acid and in need of liming for the satisfactory production of the otherwise adapted legumes.

Drainage.—As a group these soils need artificial drainage for satisfactory cropping, particularly during rainy seasons. Most areas have had tile drainage, but a few local areas need further improvement in the drainage system. Because of the open texture and the low organic-matter content, the soil tends to dry out during summer and crops suffer to some extent from drought, particularly on the deeper more sandy soils such as Aubbeenaubbee fine sandy loam.

Organic matter and nitrogen.—Because of the limited moisture-holding capacity and the need for both organic matter and nitrogen, deep-rooted, drought-resisting legumes such as alfalfa and sweet-clover should have an important place in the cropping system. Furthermore, a livestock system of farming should be followed in which the roughage and grain are almost wholly fed on the farm and the crop residues returned to the land.

Crop rotation.—When adequately drained and fertilized, the 5-year rotation of corn, soybeans, wheat, and 2 years of alfalfa-grass meadow is well suited to this management subgroup. On the slightly darker soils, such as Conover, and on areas that have somewhat better than average moisture-holding capacity, 1 year of meadow may be dropped to make a 4-year rotation. If a grain system of farming is followed, the 4-year rotation may be extended to 6 years by adding corn and grain with a sweetclover intercrop. Wheat is preferable to oats as the small grain crop in the rotation because it is almost grown before dry weather reduces crop yields.

Fertilization.—Since these light-colored sandy soils are deficient in nitrogen, it is important to grow legumes on them to supply as much of the nitrogen needs of the crops as possible. Manure should be used to the fullest possible extent, and all crop residues not otherwise utilized should go back to the land. No matter how well these practices are followed, the nonleguminous crops will need some nitrogen in the commercial fertilizer used.

Phosphates will be needed in considerable quantities because these soils are all naturally low in total content and available supply of phosphorus. The total supply of potassium is large; but since its availability is low to very low, all of the soils of this subgroup require potash fertilizer in quantities depending on the amount of manure applied.

MANAGEMENT GROUP 6—POORLY DRAINED MEDIUM-TEXTURED SOILS

Management group 6 consists of the silt loams of Bethel, Delmar, and Delmar-Bethel. Together they occupy only 252 acres, or less than 0.1 percent of the county. Most of the areas are small and occur with the imperfectly drained silt loams and loams of the Crosby and Fincastle series. Consequently, their use and management are dominated by these more extensive soils. In management the soils of this group differ from Crosby and Fincastle soils of management subgroup 5A mainly in requiring closer spacing of tile lines.

MANAGEMENT GROUP 7—VERY POORLY DRAINED, SLIGHTLY ACID TO NEUTRAL SOILS OF THE DEPRESSIONAL AREAS UNDERLAIN BY CLAYEY MATERIALS

Management group 7 consists of Brookston and Kokomo loams and silty clay loams, Millsdale silty clay loam, and Washtenaw silt loam—soils that have predominantly clayey surface soils and subsoils and as a result have certain characteristic problems of tilth and drainage. This is by far the most extensive group of soils in the county; it occupies 76,057 acres, or 28.5 percent of the total area.

Washtenaw silt loam, a light-colored soil, is not as dark on the surface as the grouping would indicate. It is included in the group for management discussion because of its close relation to the Brookston and Kokomo soils on which it has developed as an overwash from adjoining light-colored, higher lying soils. This group includes the most productive soils of the county.

Drainage.—These soils were all developed under conditions of very poor natural drainage. Cultivation is practically impossible without artificial drainage. Because of the heavy texture of the subsoil, a general lowering of the water table by a system of open ditches is impossible. Consequently, a tile drainage system has been installed in which the main lines enter either short open ditches or heads of natural drainageways.

Better drainage facilities are needed in some of the isolated and deeper depressions, usually where the present drainage system does not have enough fall to be extended. In some situations satisfactory drainage outlets are not available, as in areas of Washtenaw silt loam that occupy deep kettle-hole positions completely surrounded by much higher land. This is also true of some flat or saucerlike areas of Millsdale silty clay loam that are underlain by rock at approximately 3 feet.

Where more drainage is needed, particularly in ponded areas, and suitable outlets are available, adequate tile drainage should be provided to carry off the accumulating surface water and thus prevent continued drowning of crops after heavy rains.

Liming.—With the exception of Washtenaw silt loam, the soils of this group are neutral to only slightly acid in reaction, and consequently need no lime. Some of the lighter colored areas of Washtenaw silt loam may need a light application of lime.

Organic matter and nitrogen.—The soils of this group are well supplied with organic matter and nitrogen. With reasonable care in the management of these soils, no special provisions for supplying these constituents will be necessary for a long time, although it will generally be advisable to have a little quickly available nitrogen in the fertilizer for wheat and vegetable crops. Washtenaw silt loam will be benefited by the incorporation of all available crop residues and the growth of legumes wherever practicable. Some of the Brookston areas are not well supplied with organic matter or nitrogen. These constituents should be maintained on such areas by growing legumes and turning under or working into the surface all crop residues.

Crop rotation.—This management group includes soils that are some of the best in the county after they are drained. After proper attention to drainage, the most important requirement, and liming where needed, they will produce all the ordinary crops adapted to the region. They are suitable either for a grain or a livestock system of farming. Among the rotations that may be satisfactorily employed on most of

these soils are (1) a 6-year rotation of corn, soybeans, wheat, meadow, corn, small grain (with a sweetclover intercrop), (2) a 4-year rotation of corn, soybeans, wheat or oats, and mixed hay; or (3) a 3-year rotation of corn, wheat or oats, and mixed hay. Where more corn is desired and there is no serious soil tilth problem, such as may occur on the silty clay loam soils, more intensive rotations may be used, such as corn, corn, soybeans, wheat or oats, and mixed hay. A mixed seeding for the hay crop is gaining favor as compared with the clover alone or clover and timothy seedings commonly used in the past, because it lessens the danger of an unsatisfactory stand.

On most of these soils where adequate drainage has been provided and soil acidity is not a limiting factor, alfalfa and sweetclover can be grown alone if desired. All of these soils will produce excellent bluegrass pastures, although only poorly drained areas are so used.

The better drained and more friable areas of these soils will produce good crops of various vegetables when satisfactory markets are available and the extra labor problems can be handled. Tomatoes and sweet corn are well suited to these soils and are most frequently grown.

Fertilization.—The soils of this group are well supplied or fairly well supplied with nitrogen, and as a rule the row fertilizer need not contain nitrogen for any of the ordinary field crops except wheat. On farms having both light-colored and dark-colored soils, the manure should be applied on the light-colored areas where both the nitrogen and organic matter are needed most.

The total quantities of phosphorus in these soils are larger than in the light-colored soils. These quantities, however, are not large enough to warrant drawing upon them to any considerable extent, although in the soil analysis table some of the heavier types in this group show high availability. The total content of potassium is large in all of these soils, but the available supplies are generally low.

In most cases it pays to have a little nitrogen in the fertilizer for wheat, especially since it is advisable to sow late in order to escape hessian fly infestation, and enough phosphate and potash to take care of the needs of the hay crop to follow. The 3-12-12 analysis may be best for the heavier textured soils, and the 3-9-18 for the lighter textured ones. The rate of application should be 400 pounds or more to the acre. Where oats are the small grain crop in the rotation and clover or a legume-and-grass mixture for hay is to be seeded with it, 300 or more pounds to the acre of 3-12-12 should be drilled. Where soybeans follow well-fertilized corn, they need not be specially fertilized, at least on the better soils.

On the poorer soil areas that have not been previously well fertilized, it usually pays to use some phosphate and potash fertilizer, such as 0-10-20. It should be applied at the rate of 400 pounds or more an acre, plowing under two-thirds of it and applying one-third on both sides of the row at planting time with a divided fertilizer attachment on the planter.

MANAGEMENT GROUP 8—VERY POORLY DRAINED SLIGHTLY ACID TO NEUTRAL SOILS OF THE DEPRESSIONAL AREAS UNDERLAIN BY STRATIFIED GRAVEL AND LOAMY MATERIALS

The soils of management group 8 include Abington and Westland silty clay loams; Abington, Lear, Nyona, and Maumee loams; and Maumee fine sandy loam. They occupy 12,575 acres, or 4.8 percent

of the total area of the county. In texture the Westland and Abington silty clay loams are more closely related to the previous group (management group 7) in their management problems, whereas the Maumee fine sandy loam has the loose open texture of the soils of management group 9.

Drainage.—Like the preceding group, these soils were formed under very poor natural drainage conditions; consequently cultivation was impossible without artificial drainage. The water table can be effectively lowered for an area by providing a system of open ditches. Tile drainage is used to a limited extent for the laterals reaching to detached or remote areas. Usually little difficulty is found in getting outlets, but some deep cuts may be necessary through sand-dune areas to reach a few scattered or isolated marshlands. Tile drainage systems laid in gravel or loose sand that occurs at shallow depths may have a high maintenance cost, as they tend to sand-in readily at the joints. Deep open-ditch drainage of such soils may lower the water table excessively and result in drought reduction of crop yields adjacent to the ditch.

Liming.—Like the heavier textured dark-colored soils of management group 7, these soils are neutral to slightly acid in reaction. As a group they do not need lime, but a higher proportion of them than of soils of group 7 are slightly acid. Soil tests should be made where there is some indication that lime may be needed.

Organic matter and nitrogen.—Although soils of this group are reasonably well supplied with organic matter, they have a loose, somewhat open texture that favors more rapid decomposition, particularly under a grain system of farming in which a higher proportion of clean-tilled crops is grown. This characteristic is particularly true of Maumee fine sandy loam. Constant attention should be given to the maintenance of organic matter by the growing of legumes and by working into the surface all crop residues. No residues should ever be burned or otherwise wasted.

Crop rotation.—The soils included in this group are all fertile and capable of a high level of productivity. Because of their higher sand content, however, they are somewhat less durable than the soils of management group 7 if they are not adequately fertilized. They occur in somewhat larger and more uniform areas and are as well or better adapted to grain farming, provided they are liberally fertilized. All of the crop rotations listed for management group 7 are suitable for this group, including those in which a higher proportion of corn is grown, or in which corn is grown in 2 successive years. A rotation of corn, soybeans, and wheat with a sweetclover intercrop is well suited, if liberal amounts of nitrogen and mixed phosphorus and potash fertilizer are applied to maintain yields. As sweetclover requires a nearly neutral soil, probably much of this group would have to be limed to secure a good soil-building stand of this crop. Oats often are grown in place of wheat because of the considerable winterkilling of the latter resulting from standing water.

Fertilization.—Although these soils have above average amounts of nitrogen, additional amounts are needed to produce high yields of grain crops, especially corn and wheat. The total quantity of both phosphorus and potash is larger than in the light-colored soils, but available amounts are relatively low and about equally deficient,

especially in the Lear, Maumee, and Nyona soils. On these soils corn usually should be given about 200 pounds of 0-10-20 fertilizer. Soybeans require a similar fertilizer with a high proportion of potash.

MANAGEMENT GROUP 9—VERY POORLY DRAINED STRONGLY ACID SOILS OF THE TERRACES UNDERLAIN BY STRATIFIED SAND

Newton loam and fine sandy loam and Dillon fine sandy loam make up management group 9. They occupy 3,062 acres, or 1.2 percent of the total area of the county. These soils are fairly well to well supplied with nitrogen and organic matter but are predominantly poor in available phosphate and potash. They all need artificial drainage, which, because of the sandy substratum, is best accomplished by open ditches. The soils of this group are strongly acid and require heavy liming for successful cropping.

Drainage.—Like the other two groups of dark-colored depressional soils, these soils must have artificial drainage to be successfully cropped. Because of the sandy subsoil, drainage is easy if outlets are obtained, usually through open ditches. Even though most of these soils have been drained, many areas require additional drainage to remove the surface water occurring in the winter and during the wet spring season. Wherever possible controlled drainage should be effected so that the water table can be raised during summer dry periods.

Liming.—The Dillon and Newton soils are strongly acid and require heavy liming before any other beneficial soil treatment can be fully effective. At least 3 tons per acre of ground limestone is required as an initial treatment, and a ton or more may be required every 4 or 5 years.

Organic matter and nitrogen.—These soils are naturally well supplied with organic matter, but because they are sandy and well aerated the supply is rapidly broken down. Constant effort therefore should be made to return all crop residues and build up the organic supply where possible with legumes.

Crop rotation.—With controlled drainage, adequate liming, and proper fertilization, these soils will produce moderately good crops of corn, soybeans, oats, and in some cases wheat. Alfalfa and other legumes have not been too successfully grown. Where drainage cannot be controlled, a 4-year rotation of soybeans, oats, and mixed grass-legume meadow for 2 years has been satisfactory. During the dry summer months, soybeans are able to withstand the drought conditions better than corn. Oats are more successfully grown than wheat, because they are spring seeded and reach maturity before drought becomes serious. Winterkilling and excessive amounts of surface water in the spring frequently combine to produce thin stands and low yields of wheat. A mixture of red clover, alsike, and timothy is best able to withstand the acidity and moisture conditions on these soils. It produces a fair meadow stand, although the soil-improving value of the legume may be of limited value.

Fertilization.—In the fertilization of these dark-colored sandy soils, it should be recognized that available soil potassium and phosphorus supplies are very low. Consequently 0-10-20 or a similar analysis is needed on corn and soybeans, and 3-9-18 is needed on small grain. Where drainage is adequate, wheat gives excellent

response to spring applications of 20 pounds or more of nitrogen to the acre.

MANAGEMENT GROUP 10—ORGANIC SOILS

Management group 10 includes Carlisle muck, Carlisle silty muck, and Wallkill silt loam. Together these soils occupy 5,832 acres, or 2.2 percent of the total area of the county. Carlisle muck greatly predominates. Wallkill silt loam is included in this management group because of its close association with the muck soils on which it is developed as overwash material from adjoining higher lying mineral soils.

Profitable management of these soils involves careful drainage, control of wind erosion of the light surface muck when dry, the growing of suitable crops, and the application of adequate quantities of mineral fertilizer especially rich in potash. Carlisle muck is very deficient in potash. Wallkill silt loam is fairly well supplied with potash in the upper horizons, the supply depending on the depth to the underlying muck, and may not need much fertilizer for some time.

The question is sometimes asked whether muck soils can be improved by burning. Mucks cannot be improved permanently by burning, and they may be seriously injured. Burning adds nothing. On the other hand, it destroys valuable organic matter and nitrogen. The mineral plant food elements concentrated in the ash remains are not to be considered as gain because they were already there and after burning will soon be used up. The land is left in a poorer condition than before burning because of the destruction of organic matter and the consequent lowering of the land level in many places to such an extent that drainage is more difficult or the present drainage system is damaged.

Drainage.—In improving muck soils, the first requisite is proper drainage. As a general rule, the water table should be lowered to 3 feet below the surface. For meadows and pastures, a depth of 2 feet to the water table may be enough for best results. Muck soils will drain freely if the water has a chance to get away. It is not necessary for ditches or tile lines to be as close together as in the heavier soils. Ordinarily, the distance between tile lines or lateral ditches should be 100 feet. Whether tile or open ditches should be used depends on local conditions. If the subsurface material is sufficiently firm to hold tile in place, tiling is preferable, since open ditches are always a nuisance. In extensive areas large open outlet ditches may be necessary. These, however, should not be deeper than is necessary to provide outlets for tile lines and to keep the water table at a proper level to meet the needs of crops.

Most muck areas receive considerable surface and seepage water from the adjoining higher lands. The drainage plan should therefore provide for the removal of such waters near their source as well as the removal of the excess rainwater that falls directly on the muck area. The first thing to be done is to cut a ditch or lay a line of tile along the edge of the muck next to the adjoining higher land. This will catch the seepage and runoff from the higher land and make the drainage of the muck area comparatively easy, provided a suitable outlet can be procured.

Muck soils should not be too deeply drained, because the crops grown on them are apt to suffer from lack of moisture at critical

times in prolonged dry spells. However, where tile drainage is installed, the lines of tile must be placed deep enough so that subsequent settling of the soil will not leave them too near the surface. After it is drained and under cultivation, muck settles considerably within the first few years, and allowances for this settling should be made. Great care should be exercised to establish an even grade for each line of tile, so that the flow of water will be uniform. Fine materials that wash in at the tile joints settle easily and soon will clog the tile if the grade is uneven. As a rule, nothing smaller than 5-inch tile should be used in muck soils. It is a good plan to cover the tile with a few inches of straw or grass and weeds before filling the ditches. This practice will keep much fine material out of the tile while the ground is settling.

In some places it may be desirable to raise or hold up the water table when the dry season of the year approaches, especially for shallow-rooted crops. This can be done to some extent by temporarily damming the ditches or blocking the tile outlets until sufficient rains come again. Drainage so controlled will reduce the shrinkage of the muck as well as result in heavier yields of shallow-rooted crops.

Liming.—For most crops the soils of this group are not sufficiently acid to require liming. Where a crop that particularly needs a neutral or alkaline soil reaction is to be grown, light liming especially for this crop should be practiced. If there is doubt, advice should be procured from the Purdue University Agricultural Experiment Station at LaFayette, Ind.

Crops for organic soils.—These soils, when properly drained and fertilized, may be used satisfactorily for most of the field and garden crops adapted to the climatic conditions of the region. Wheat, oats, and barley and many truck and garden crops are not so well adapted as to mineral soils. Where satisfactory markets and necessary labor are available, specialized truck farming is excellently suited to Carlisle muck and Carlisle silty muck. Potatoes, onions, carrots, beets, celery, parsnips, spinach, lettuce, cabbage, cauliflower, rutabagas, and other vegetable crops can be grown. Sweet corn and mint also will do well. Details concerning production practices for any of these crops can be procured from the Department of Horticulture of the Agricultural Experiment Station at Lafayette, Ind.

For the general farmer, corn is the most popular and generally the best crop for these soils; and with proper fertilization, may be grown most of the time. It is necessary, however, to use early-maturing varieties of corn in order to escape early frosts. The small grains are the least suitable crops for organic soils, because they are apt to produce a rank growth of weak straw and lodge badly. Soybeans, sorghum, Sudangrass, and bluegrass for pasture are well adapted to these soils and may be fitted readily into cropping systems.

Importance of compacting muck soils.—One of the difficulties encountered in managing the highly organic soils, like Carlisle muck, is their tendency to be too loose on the surface. In preparing the seedbed, therefore, it is important to pack the ground thoroughly by the use of a heavy corrugated roller, and to go over the field more than once if necessary. Thoroughly compacting the muck at planting time not only helps to get a more even germination of seeds and better early growth, but also lessens the danger of early frost damage to immature crops.

Windbreaks.—The prevention of wind erosion during early dry periods and of the blowing out of tender crops while they are still small are ever-present problems on these muck soils. The simplest practice is to plant a row of rye for every few rows of tender seedlings. Some muck farmers plant certain species of willows or pines crosswise to the direction of the most damaging winds.

Fertilization.—In the fertilization of crops on highly organic soils like Carlisle muck, potash is of first importance and should be the major constituent of fertilizer applications. Carlisle silty muck does not need so high a proportion of potash fertilizer. Wallkill silt loam has a fair supply of available potash. All of the soils of this group need some available phosphate. Nitrogen is present in great abundance in Carlisle muck and Carlisle silty muck. It need not be applied in fertilizer on these soils except for early planted vegetable crops that require quickly available nitrogen, particularly in late seasons when nitrification (the bacterial action that makes soil nitrogen available) does not begin early enough. The lighter colored areas of Wallkill silt loam are not so well supplied with nitrogen, and if used for vegetable crops, they will generally need some in the fertilizer.

In general farming, corn should be fertilized with 0-9-27 on Carlisle muck, 0-10-20 on Carlisle silty muck, and 0-12-12 or 0-10-20 on Wallkill silt loam at rates of 200 to 400 pounds an acre. Soybeans may be similarly fertilized; part of the application should be plowed down. For sorghum, Sudangrass, and mint, the fertilizer may be broadcast and disked in, or placed 4 or 5 inches deep through a fertilizer attachment on a grain drill. Bluegrass pastures should be topdressed with 0-12-12 or 0-10-20 every 2 or 3 years.

Truck and garden crops that may be grown on these soils will need special fertilization. Details of fertilization for each crop and local condition can be obtained from the Purdue University Agricultural Experiment Station at Lafayette, Ind.

On areas of muck just brought under cultivation, applications of partially rotted manure will be helpful in supplying beneficial bacteria, which often are lacking in newly cultivated mucks.

MANAGEMENT GROUP 11—WELL-DRAINED SOILS OF THE BOTTOM LANDS

Management group 11 consists of Genesee silt loam, Genesee loam, and Genesee fine sandy loams. These soils cover an area of about 3,500 acres, or 1.3 percent of the county. Most of the Genesee soils of the larger bottoms are under cultivation. The greatest difficulty in the management is to provide adequate drainage and to prevent damage from flooding. All of them are neutral to mildly alkaline and have no need for liming.

Drainage.—Natural drainage is limited by periodic overflow and, in the heavier types, by slowly permeable subsoils. Water drains off quickly into the swales or is taken in rapidly through the permeable subsoil and recedes with the water table.

Organic matter and nitrogen.—Genesee loam and Genesee silt loam contain moderate amounts of organic matter, but the Genesee fine sandy loam is low in this constituent. On the larger bottoms, continuous cropping to corn has depleted the organic-matter supply and reduced crop yields. Cornstalks and other crop residues should be returned to the soil, and wherever possible legumes should be included in the rotation. Alfalfa can be grown successfully on most of the

higher areas of Genesee loam and fine sandy loam. Sweetclover should be grown as a soil-improving crop, either as an intercrop seeded in small grain or seeded in corn at the last cultivation. This latter practice has been most successful where the corn rows have been spaced wider to admit sunlight, moisture supplies have been adequate at seeding time, and the soil has been liberally fertilized. Seed inoculation is necessary where the crop has not been previously grown.

Crop rotation.—Where flooding cannot be prevented, the crop rotation must consist largely of annual spring-seeded crops and such grasses and clover mixtures as will not be seriously injured by overflow. Corn and soybeans, which can be planted after the worst spring floods are past, are the most dependable crops for these bottom lands. If properly fertilized, corn can be grown repeatedly on all the bottom lands except Genesee fine sandy loam without much decrease in yields. On the higher areas of Genesee soils where the floods are of short duration and the water runs off quickly, alfalfa and sweetclover may also be grown. For such areas, a 3-year rotation of corn, corn or soybeans, and wheat or oats with a sweetclover intercrop will greatly improve the corn yields and help in the control of weeds. Sweet corn, tomatoes, and other vegetables are well adapted on the Genesee soils and may be satisfactorily produced for local markets.

Fertilization.—On overflow bottoms that receive deposits of silt from fertile uplands, there is not much need for fertilizer. Fertility experiments with corn on these soils indicates the greatest response to applications of nitrogen and little response to either phosphorus or potash on the finer textured soils. However, where the land has been cropped for a considerable length of time, especially on the more sandy areas, it pays to apply 100 to 200 pounds of 3-12-12 with a plowdown or sidedressing application of 40 to 80 pounds of elemental nitrogen per acre. On the more sandy areas, an analysis containing a higher proportion of potash may be more profitable, as available phosphorus is usually adequate. On the poorer and more sandy areas, soybeans respond well to a fertilizer high in potash, such as 0-10-20.

MANAGEMENT GROUP 12—MODERATELY WELL DRAINED AND IMPERFECTLY DRAINED SOILS OF THE BOTTOM LANDS

Eel silt loam and loam, and Griffin fine sandy loam are the soils of management group 12. They cover an area of about 7,200 acres, or 2.7 percent of the county. Griffin fine sandy loam occurs in narrow strips and small patches along drainageways. It is frequently flooded, and little of it can be cultivated. Most of it is used for permanent pasture or is forested. The Eel soils are the principal soils of small stream bottoms and old meander channels of the larger streams. Like the Griffin, they are used chiefly for pasture because of frequent overflow.

Drainage.—The greatest problems in cropping these soils are the provision for adequate drainage and the prevention of flooding where feasible. Little can be done to drain the lower lying swales and old meander channels unless there is adequate fall to provide tile outlets.

Organic matter and nitrogen.—The Eel soils were naturally above average in organic matter and nitrogen. However, on the larger bottoms continuous cropping to corn has depleted the supply of

easily decomposable organic matter and brought a decline in good soil tilth.

All crop residues such as cornstalks, soybean haulm, and straw should go back into the soil. Sweetclover is well adapted and is an excellent crop to use periodically to replenish the organic-matter supply and to improve soil tilth.

Crop rotations.—Where periodic flooding in winter and spring occurs, the rotation should consist largely of annual spring-seeded crops and grasses and clover mixtures that are not seriously damaged by overflow. Crops like corn and soybeans, which can be planted after the hazard of spring floods has passed, are the most dependable for these soils. High yields can be maintained with continuous corn if adequate amounts of fertilizers are used and an occasional small grain-sweet clover combination is included to maintain soil tilth.

Fertilization.—On the finer textured soils of the overflow bottoms that receive deposits of silt from the upland, nitrogen is often the only nutrient element that gives consistent response. Where heavy cropping has been practiced for a number of years, it may pay to apply phosphorus and potash fertilizers.

MORPHOLOGY AND GENESIS OF SOILS

Soil is the product of the forces of weathering and development acting on parent soil material deposited or accumulated by geologic agencies. The characteristics of the soil at any given point depend on (1) the physical and mineralogical composition of the parent material; (2) the climate under which the soil material has accumulated and has existed since accumulation; (3) the plant and animal life in and on the soil; (4) the relief, or lay of the land; and (5) the length of time the forces of development have acted on the soil material. The climate, and its influence on soils and plants, depends not only on temperature, rainfall, and humidity but also on the physical characteristics of the soil or soil material and on the relief, which, in turn, strongly influences drainage, aeration, runoff, erosion, and exposure to sun and wind.

ENVIRONMENT AND CHARACTERISTICS OF THE SOILS OF THE AREA

Cass County lies in the region of Gray-Brown Podzolic soils that occupy the east-central parts of the United States.⁹ Most of the soils have developed under a heavy forest cover of deciduous trees, with sufficient rainfall to wet the soil to an indefinite depth; therefore a moist condition is maintained throughout the soil except in short periods. The climatic and biological conditions permit only a relatively thin surface accumulation of organic litter and a few inches of dark-colored soil in the upper part of the profile. The surface mat of organic matter is thinner than in the Podzol region to the north but thicker than in the Red-Yellow Podzolic region to the south. All soils, except the very poorly drained ones, are light colored and relatively low in organic-matter content, and they vary from medium to strongly acid in the solum.

The soils of Cass County have developed mostly from drift of the Wisconsin glaciations. The parent material is unconsolidated sand, silt, clay, gravel, and rock fragments deposited as terminal moraines,

⁹ BALDWIN, M. THE GRAY-BROWN PODZOLIC SOILS OF THE EASTERN UNITED STATES. Internatl. Cong. Soil Sci. Proc. and Papers 4:276-282. 1928.

ground moraines, glaciofluvial outwash plains, and terraces. Some areas have relatively thin deposits (12 to 36 inches) of silty material (probably loess) overlying the drift. Both mineral and organic soils are represented, the mineral soils comprising over 95 percent of the area of the county.

CLASSIFICATION OF SOILS

The great soil groups represented in Cass County include Gray-Brown Podzolic soils, Brown Forest soils, Planosols, Humic Gley soils, Alluvial soils, and Organic soils.

GRAY-BROWN PODZOLIC SOILS

The Gray-Brown Podzolic group includes the Miami, Russell, Metea, Bellefontaine, Fox, Bronson, Hartman, Milton, Coloma, Plainfield, Berrien, Ottawa, Crosby, Fincastle, Homer, Conover, and Aubbeenaubbee series.

The characteristics of this Gray-Brown Podzolic group of soils of the region are best expressed by the well drained and moderately well drained members. Carbonates have been removed by leaching to depths of 20 inches or more, and there has been deposition of sesquioxides in the B horizon of most of the soils.

The characteristics of the Miami soils are those of a modal Gray-Brown Podzolic soil with clay accumulation or development in the B horizons.

Profile description of Miami silt loam taken in a forested area (NW¼ NW¼ sec. 35, T. 25 N, R. 2 E) is as follows:

- A₀ Thin accumulated layer of leaves, moss, and forest mold about ½ inch thick.
- A₁ 0 to 3 inches, dark grayish-brown fine crumb silt loam containing a large quantity of organic matter and a mass of roots; a slight indication of laminated structure, with cleavage lines very feebly expressed; very slightly acid.
- A₂₁ 3 to 6 inches, light grayish-brown friable silt loam; a slight indication of laminated structure; organic-matter content low and few roots present; worm activity conspicuous; slightly acid.
- A₂₂ 6 to 11 inches, grayish-yellow to yellowish-brown silt loam that breaks into small subangular blocky aggregates, from ¼ to ½ inch in diameter, and has a thin gray coating on the cleavage faces; medium acid; increased worm activity.
- B₁ 11 to 15 inches, yellowish-brown silty clay loam; breaks into subangular blocky aggregates of ¼ to 1 inch in diameter, some of the cleavage faces having a thin coating of gray silty material; strongly acid.
- B₂₁ 15 to 27 inches, yellowish-brown silty clay loam to clay loam breaking into coarse subangular aggregates; plastic when moist and hard when dry; medium acid.
- B₂₂ 27 to 30 inches, light brownish-yellow heavy silty clay loam having a structure similar to the above layer but the material less compact; occasional spots and streaks of gray material in lower part; neutral.
- C 30 inches +, yellowish-gray highly calcareous glacial till containing some grit and small angular rock fragments; breaks into large irregular-shaped chunks.

Variations in Miami soils from the above profile are in the texture and thickness of the various horizons and in the depth to calcareous till.

Russell silt loam is developed on thin deposits (12 to 36 inches) of silty material, thought to be loess, over calcareous till of Wisconsin age. Russell silt loam differs from Miami silt loam in having silt in the A and upper B horizons, a higher acidity, and a greater depth to lime carbonates. The mechanical analysis of Russell silt loam (table

11) shows the high silt content to a depth of 30 inches; a sharp decrease in silt between the 30- to 34-inch horizon and the 34- to 48-inch horizon; and the sharp increase in particles larger than 2 mm. between these horizons. The probability that the upper part of the profile was developed from material similar to the B₂₄, C₁, or C₂ horizon is remote.

The A and upper B horizons of the Metea soil are sandy to an average depth of 26 inches. The lower B and the C horizons are similar to those of the Miami soils. The underlying material is calcareous till.

Bellefontaine soils are characterized by a heavy gravelly clay loam B horizon and a substratum of gravel and coarse sand in which cross-bedding is conspicuous.

Profile description of Bellefontaine fine sandy loam in a forested area having a good stand of walnut, oak, and hickory (SE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 4, in Jefferson Township) is as follows:

- A₀ Thin accumulated layer of leaves, leafmold, and moss $\frac{1}{4}$ inch thick.
- A₁ 0 to 3 inches, dark grayish-brown very friable fine sandy loam; aggregates are very fragile and break easily into a uniform single-grain mass; a mass of roots and much organic matter present; worm activity high; slightly acid.
- A₂ 3 to 11 inches, pale brownish-yellow very friable fine sandy loam; some evidence of a fine subangular blocky structure but most of the aggregates are irregular and have a rather definite crushing point, breaking into very small crumbs; medium acid.
- B₁ 11 to 18 inches, yellowish-brown light sandy clay loam having a medium subangular blocky structure; strongly acid.
- B₂₁ 18 to 26 inches, yellowish-brown compact sandy clay loam; breaks into very coarse subangular aggregates that break down under pressure into a loose gritty mass; medium acid.
- B₃₂ 26 to 38 inches, brown to weak reddish-brown compact sandy clay loam; strongly acid.
- B₂₃ 38 to 41 inches, dark reddish-brown gravelly and sandy clay loam; breaks into irregular-sized lumps; not so compact as the horizon immediately above and somewhat darker in color; neutral.
- C 41 inches +, loose assorted and crossbedded highly calcareous gravel and sand.

Bellefontaine soils vary from the above profile in the texture and thickness of the various horizons. They occupy the kames, eskers, and morainic hills in the upland areas.

Fox soils are very similar to Bellefontaine soils in profile characteristics and vary in the surface texture and in the thickness of the various horizons. The heavy B horizon usually contains more gravel than the B horizon in Bellefontaine soils, and the substratum of gravel and coarse sand has horizontal stratification. The deep phase of Fox soils has much thicker A and B horizons; loose gravel is encountered at a depth of 60 inches.

Bronson fine sandy loam differs from Fox fine sandy loam in being mottled in the B horizon and in having a slightly higher organic-matter content in the surface soil.

Hartman soils are located on the low terraces along the Wabash and the Eel Rivers and occupy a position intermediate between Fox and Genesee soils. There is a weak B development, and the underlying material is largely composed of rock rubble.

Milton silt loam is developed on glacial drift underlain by limestone bedrock at a depth of less than 40 inches. It occurs on benches and high terraces along the Wabash River and Pipe Creek and is not subject to overflow.

Coloma, Plainfield, Berrien, and Ottawa soils have weakly developed sandy Gray-Brown Podzolic profiles and in this respect have some characteristics of Regosols.

In a wooded area in NE $\frac{1}{4}$ sec. 9, T. 28 N., R. 2 E., the following profile of Coloma loamy fine sand was observed:

1. Thin accumulation of leaves, twigs, and moss, less than $\frac{1}{2}$ inch thick.
2. 0 to 2 inches, dark brownish-gray loose loamy fine sand containing many roots and enough organic matter to give the mass a very slight cohesiveness; slightly acid.
3. 2 to 8 inches, grayish-brown loose loamy fine sand; organic matter content sufficient to stain the material; few stones present; slightly acid.
4. 8 to 13 inches, yellowish-brown loose fine sand; darker colored material from above penetrates this layer, giving it a streaked appearance; medium acid.
5. 13 to 20 inches, brownish-yellow loose fine sand; pockets and streaks of darker material, evidently old root channels, are conspicuous; strongly acid.
6. 20 inches +, yellow sand with streaks and pockets of gray material; deep substratum, calcareous till, occurring at depths of 6 to 20 feet or more.

Coloma soils occur on slightly higher and more rolling topography than the Miami soils. They are located north of the Wabash River in the Steuben Morainal Lake section of the Northern Moraine and Lake Region. The presence of large stones on the surface and in the profile discredits the assumption that these soils are the direct result of wind action.

Plainfield soils are fluvioglacial deposits that have been reworked by wind action. The profile is similar to Coloma soils, but the acidity is slightly greater.

The moderately well drained Berrien soils occur on the fluvioglacial outwash plain regions and are developed on loose acid sands. The surface soil is low in organic material, and the subsoil is mottled below depths of 15 to 25 inches.

Ottawa soils are developed on sandy material over calcareous glacial till or calcareous stratified silt and clay. The depth to the calcareous material varies from 5 to 10 feet or more.

The Gray-Brown Podzolic soils developed under imperfect natural drainage conditions include the Crosby, Conover, Aubbeenaubbee, Fincastle, and Homer.

The Crosby, Fincastle, and Homer soils have fine-textured B horizons, and a somewhat sharper transition from the A to the B horizon than modal for Gray-Brown Podzolic soils. They are intergrading toward the Planosols.

Profile of Crosby silt loam in a wooded area (SE $\frac{1}{4}$ sec. 13, T. 26 N., R. 3 E.) is as follows:

- A₀ An accumulated layer of forest litter less than $\frac{1}{2}$ inch thick.
- A₁ 0 to 3 inches, dark-gray friable silt loam having a fine crumb structure; organic content relatively high; many roots present; slightly acid.
- A₂ 3 to 9 inches, brownish-gray friable silt loam breaking into small subangular blocky aggregates from $\frac{1}{4}$ to $\frac{1}{2}$ inch in diameter; thin gray silty coating appears on some of the cleavage faces and along old root channels; much worm activity; slightly acid.
- B₁ 9 to 13 inches, mottled gray, yellow, and brown silty clay loam; breaks into small to medium subangular blocky aggregates that crumble with some pressure into coarse granular material; medium acid.
- B₂₁ 13 to 24 inches, mottled gray and yellow clay loam or silty clay loam; breaks into coarse, well-developed subangular blocky aggregates; slightly plastic when moist and hard when dry; medium acid.

B₂₂ 24 to 29 inches, mottled gray and pale-yellow heavy clay loam having a structure similar to the above horizon but somewhat darker in color; this is the transitional zone between the lower B horizon and the C horizon; neutral.

C 29 inches +, yellow and gray highly calcareous loam till composed of unassorted silt, clay, sand, and rock fragments.

Fincastle silt loam is similar to Crosby soils in color and natural drainage conditions, but it is developed on thin deposits (12 to 36 inches) of silt (probably loess) over loam till of Wisconsin age. Mechanical analyses of Fincastle silt loam from other areas in the State show a sharp decrease in silt content between the upper part of the profile and the lower part, similar to that shown in the mechanical analysis of Russell silt loam in table 11.

Homer silt loam occurs on the glacial terraces and is underlain at a depth of about 40 inches by stratified gravel and coarse sand similar to that underlying Fox soils. Mottling occurs in the lower A and the B horizon.

Conover soils differ from Crosby soils in having darker colored surface soils relatively high in organic matter, and in having slightly more permeable B horizons. They are classified as Gray-Brown Podzolic soils that are intergrading toward Humic Gley soils.

Aubbeenaubee fine sandy loam has sandy and not well-developed A and upper B horizons. These characteristics are representative of Gray-Brown Podzolic soils that are undergrading toward the Low Humic Gley soils—a group of imperfectly and poorly drained soils without noticeable clay accumulations in the B horizons. The underlying material of Aubbeenaubee soils is sandy loam to loam till.

BROWN FOREST SOILS

The Brown Forest soils are represented by Farmington silt loam.

Farmington silt loam has a brown to dark-brown granular silt loam surface soil and a slightly finer textured granular B horizon. It is underlain by limestone bedrock at depths varying from 8 to 16 inches.

PLANOSOLS

The Planosols include the Bethel and Delmar soils. They are developed under poor natural drainage conditions. The A horizons are dominantly gray and change rather sharply from the silty A horizons to the clayey B horizons—a characteristic of Planosols.

Bethel silt loam is developed on loam to coarse clay loam calcareous till.

Delmar silt loam is developed on thin deposits (12 to 36 inches) of silt (probably loess) over loam to coarse clay loam calcareous till. The depth to free lime carbonates averages about twice that in the Bethel soil.

HUMIC GLEY SOILS

The Humic Gley soils include the Brookston, Kokomo, Washtenaw, Westland, Abington, Nyona, Lear, Maumee, Dillon, Newton, and Millsdale series.

They have developed under very poor natural drainage conditions, with a water table at or near the surface for a large part of each year. The A horizons are high in organic matter; the B or G horizons are gray or mottled gray and yellow or brown. The underlying C or D horizons are either till, gravel, sand, or limestone.

Brookston soils are modal Humic Gley soils. In a thinly wooded area about 3 miles west of Onward, having an excellent stand of bluegrass, the following profile of Brookston silty clay loam was observed:

- A₀ A very thin accumulated layer of leaves and twigs.
- A₁₁ 0 to 2 inches, very dark-gray friable silty clay loam, high in organic-matter content and containing a mass of roots; neutral.
- A₁₂ 2 to 6 inches, very dark grayish-brown or brownish-gray friable silty clay loam having a coarse granular structure; color becomes more brown than gray when crushed; neutral.
- A₁₃ 6 to 15 inches, dark brownish-gray or dark-gray heavy silty clay loam that breaks into irregular-shaped subangular pieces; slightly plastic when wet and hard when dry; neutral.
- BG₂₁ 15 to 23 inches, dark-gray plastic clay loam with slight yellow mottling; breaks into large irregular-sized angular aggregates; sticky when wet and hard when dry; neutral.
- BG₂₂ 23 to 42 inches, mottled gray and pale-yellow fine clay loam with a few angular pebbles, neutral.
- C 42 inches +, gray and pale-yellow fine loam highly calcareous till.

Brookston soils vary from the above description in texture of the upper horizons and in depth to calcareous till. Free lime carbonates generally occur at a lower depth in the lighter textured Brookston soils than in Brookston silty clay loam.

Kokomo soils occupy the very poorly drained depressional areas associated with Brookston soils. They have a higher organic-matter content in the surface soil, and the subsoil is gray instead of mottled as in Brookston soils.

Washtenaw silt loam has a surface accumulation of silty material 6 to 20 inches thick over dark-colored heavy material similar to that in Brookston and Kokomo soils.

The general surface appearance and natural drainage conditions of Westland soil are comparable to those of Brookston soils. They occupy the depressional areas and old drainageways in the glacial terraces, associated with Fox, Abington, Homer and Bronson soils. The surface soil is dark grayish-brown and relatively high in organic-matter content. The lower A horizon is heavier in texture and lighter in color than the surface horizon. At a depth of 20 inches the subsoil is heavy, waxy, gray- and-yellow mottled gravelly clay loam, underlain at an average depth of 45 inches by stratified calcareous gravel and sand.

Abington soils are more poorly drained than the associated Westland soils. The surface soil is very dark brownish gray; it is underlain by gray heavier material. Heavy, waxy, gravelly clayey material occurs at a depth of 20 inches, and loose stratified gravel and sand at a depth of 55 inches.

Nyona soils are comparable to Brookston soils in surface appearance and the upper part of the profile but are underlain at an average depth of 40 inches by poorly assorted gravel and sand. They occur in the northwestern part of the county in association with Lear soils.

Lear loam is comparable to Kokomo soils in natural drainage, color, and thickness of the surface and upper subsoil horizons, but it is underlain by calcareous gravel and sand mixed with some poorly assorted silt and clay.

Maumee soils are developed on loose calcareous sands. They have very dark-gray surface soil and upper subsoil to a depth of 18 inches, which are underlain by gray loose sand.

Dillon fine sandy loam is similar to Maumee fine sandy loam in color, organic-matter content, and natural drainage conditions but it developed on strongly to medium acid loose sand.

Newton soils are developed on strongly acid sands. The organic-matter content of the surface soil is slightly lower than in Maumee and Dillon soils, and the loose sandy material below a depth of 14 inches is highly mottled.

Millsdale silty clay loam is a poorly drained soil. The surface soil is very dark brownish gray, and limestone bedrock occurs at depths of less than 40 inches.

ALLUVIAL SOILS

The Alluvial soils include the Genesee, Eel, and Griffin series. They occupy the flood plains of the rivers and streams and are subject to overflow. They receive periodic deposits of mineral material and thus do not have distinct horizon development.

Genesee soils represent the well-drained Alluvial soils. The surface soil is brown to grayish brown, and little or no mottling has developed above a depth of 32 inches. Depositional layers are present in the profile. Genesee soils occasionally occupy the higher parts of the bottoms.

Eel soils, as mapped in this county, are moderately well and imperfectly drained soils. They have grayish-brown to brownish-gray surface soils, and mottling of gray, yellow, and brown generally occurs at depths of 10 to 20 inches.

Griffin fine sandy loam is moderately well to imperfectly drained, and conspicuous yellow or brown streaks and splotches occur below depths of 3 to 14 inches.

ORGANIC SOILS

Only a small area of the county is covered with organic deposits, and they are separated as Carlisle muck, Carlisle silty muck, and Wallkill silt loam.

Profile description of Carlisle muck, taken in an undisturbed area (SE¼ sec. 3, T. 27 N., R. 1 E.) is as follows:

1. 0 to 5 inches, black fine granular muck, containing numerous roots; slightly acid.
2. 5 to 17 inches, black coarse granular well-decomposed muck; slightly acid.
3. 17 inches +, brown or brownish-yellow fibrous muck and partially decomposed reeds, twigs, sedges, and other vegetable material; becomes yellow fibrous peaty material with depth.

Carlisle silty muck has a surface layer composed of a mixture of muck and mineral material. The rest of the profile is similar to Carlisle muck.

Wallkill silt loam is characterized by a deposit of light-colored mineral material over muck, and in this respect is not a true organic soil. The deposit is 8 to 20 inches in depth and has been washed in from the surrounding uplands areas of mineral soils.

MECHANICAL ANALYSES

Mechanical analyses of Russell silt loam, Miami fine sandy loam, and Conover loam, in Cass County, are given in table 11.

TABLE 11.—*Mechanical analyses of Russell silt loam, Miami fine sandy loam, and CONOVER Silt Loam—NW CORNER NE $\frac{1}{4}$ NW $\frac{1}{4}$ Sec. 9, Tipton T*

Sample No.	Horizon	Depth Inches	Size class and diameter of particles				
			Very coarse sand, 2-1	Coarse sand, 1-0.5	Medium sand, 0.5- 0.25	Fine sand, 0.25-0.1	Very sand, 0.1-0.0
			Percent	Percent	Percent	Percent	Percent
284901-----	A ₁₁	0-1	0.2	1.0	1.3	2.5	
284902-----	A ₁₂	1-3	.3	.8	1.0	1.1	
284903-----	A ₂	3-7	.3	.5	.7	1.4	
284904-----	B ₁	7-10	.0	.3	.4	.7	
284905-----	B ₁₁	10-24	.0	.2	.3	.5	
284906-----	B ₁₂	24-30	.7	1.1	1.8	3.3	
284907-----	B ₂	30-34	.5	1.7	3.1	6.2	
284908-----	B ₂₁	34-48	6.9	14.9	19.4	18.7	
284909-----	C ₁	48-70	3.2	6.9	10.2	20.9	
284910-----	C ₂	70-80	4.3	7.9	11.1	20.4	
MIAMI FINE SANDY LOAM--NE $\frac{1}{4}$ SW $\frac{1}{4}$ Sec. 35, BETHLEHEM T							
284927-----	A ₁	0-2	2.1	5.5	9.3	26.8	1
284928-----	A ₂	2-7	3.7	5.4	8.6	26.8	1
284929-----	B ₁	7-12	2.8	5.1	8.5	24.5	1
284930-----	B ₁₁	12-20	1.5	4.4	7.6	21.4	1
284931-----	B ₂	20-25	1.8	3.9	7.1	20.8	1
284932-----	B ₂₁	25-29	2.0	4.2	7.3	20.2	1
284933-----	C	29-40	2.9	5.0	7.1	21.4	1
CONOVER LOAM--SE $\frac{1}{4}$ NW $\frac{1}{4}$ Sec. 3, BOONE TOWNSHIP							
284939-----	A ₁₁	0-3	1.9	5.4	10.5	22.7	1
284940-----	A ₁₂	3-7	1.9	4.6	9.6	21.2	1
284941-----	A ₂	7-14	2.1	4.3	7.6	14.9	1
284942-----	B ₁₁	14-20	1.9	5.2	8.3	17.7	1
284943-----	B ₂₁	20-28	2.8	7.1	9.7	18.9	1
284944-----	C	28-40	4.9	7.8	9.3	17.4	1

SOIL SURVEY METHODS AND DEFINITIONS

Soil surveying consists of the examination, classification, and mapping of soils in the field. The soil scientist walks over the area at intervals not more than one-quarter mile apart and bores into the soil with an auger or digs holes with a spade. Each such boring or hole shows the soil to consist of several distinctly different layers, called horizons, which collectively are known as the soil profile. Each of these layers is studied carefully for the things about it that affect plant growth.

The color of each layer is noted. The darkness of the topmost layer is usually related to its content of organic matter; streaks and spots of gray, yellow, and brown in lower layers generally indicate poor drainage and poor aeration.

Texture—the content of sand, silt, and clay in each layer—is determined by the feel of the soil when rubbed between the fingers and is checked by mechanical analyses in the laboratory. Texture has much to do with the quantity of moisture the soil will hold available to plants, whether plant nutrients or fertilizers will be held by the soil in forms available to plants or will be leached out, and the difficulty or ease of cultivating the soil.

Structure, or the way the soil granulates, and the proportion of pore or open space between particles determine the permeability or perviousness of the soil, and consequently the ease with which plant roots penetrate the soil and water enters it.

Consistence, or the tendency of the soil to crumble, or to stick together, determines the degree of difficulty that will be encountered in keeping the soil open and porous under cultivation. Consistence covers such soil characteristics as hardness, friability, plasticity, stickiness, compactness, toughness, and cementation.

The kind of rocks from which the soil has been developed, or its parent material, affects the quantity and kind of plant nutrients the soil may have naturally. Simple chemical tests show how acid the soil may be.¹⁰ The depth to bedrock or to compact layers is determined. The quantity of gravel or rocks that may interfere with cultivation, the steepness and kind of slope, the quantity of soil lost by erosion, and other external features are observed.

On the basis of all these characteristics, soil areas that are much alike in the kind, thickness, and arrangement of their layers are mapped as one soil type. Some soil types are separated into two or more phases. A soil type will be broken into phases primarily because of differences in the soil other than those of kind, thickness, and arrangement of layers. The slope of a soil, the frequency of outcropping bedrock, the extent of its erosion, or the artificial drainage used on the soil are examples of characteristics that might cause a soil type to be divided into phases.

Two or more soil types may have similar profiles; that is, the soil layers may be nearly the same, except that the texture, especially of the surface layer, will differ. As long as the other characteristics of the soil layers are similar, these soils are considered to belong in the same soil series. A soil series therefore consists of all the soil types,

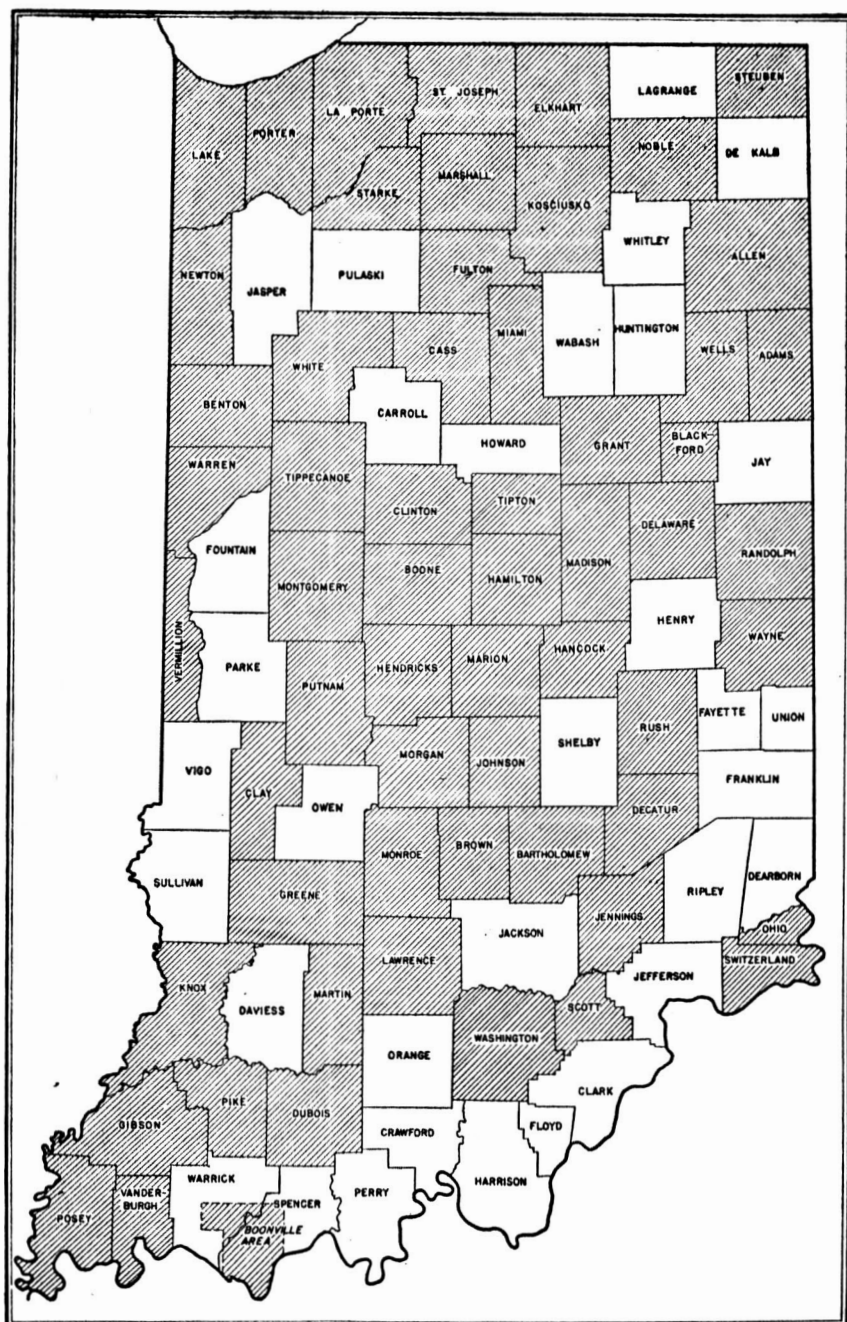
¹⁰ The reaction of the soil is its degree of acidity or alkalinity expressed mathematically as the pH value. A pH value of 7 indicates precise neutrality, higher values, alkalinity, and lower values, acidity.

whether the number of such soil types be only one or several, that are, except for texture—particularly the texture of the surface layer—about the same in kind, thickness, and arrangement of layers.

The name of a place near where a soil series was first found is chosen as the name of the series. Thus, Miami is the name of a well-drained light-colored soil series found on medium-textured highly calcareous glacial till in Cass County. Three types of the Miami series are found—Miami fine sandy loam, Miami loam, and Miami silt loam. These differ in the texture of the surface soil, as their names show. Miami silt loam is divided into three phases because some of it is undulating, some is moderately sloping, and some is steep. These three phases are Miami silt loam (the undulating phase), Miami silt loam, sloping phase, and Miami silt loam, steep phase.

Areas that have little true soil are not designated with series and type names but are given descriptive names, such as Limestone rockland, Made land, and Riverwash.

The soil type, or where the soil type is subdivided, the soil phase, is the unit of mapping in soil surveys. It is the unit or the kind of soil that is most nearly uniform and has the narrowest range of characteristics. For this reason land use and soil management practices can be more definitely specified for it than for broader groups of soils that contain more variation. One can say, for example, that soils of the Miami series need lime for alfalfa; but Miami silt loam (with 2 to 6 percent slopes) has mild slopes, and, in addition to needing lime; is suited to row crops in a rotation with small grain and hay; whereas Miami silt loam, steep phase, has slopes that fall more than 20 feet in 100, is hard to work with heavy machinery, erodes easily, and should be used principally for long-term hay or pasture. Both are included in the Miami series.



Areas surveyed in Indiana shown by shading.

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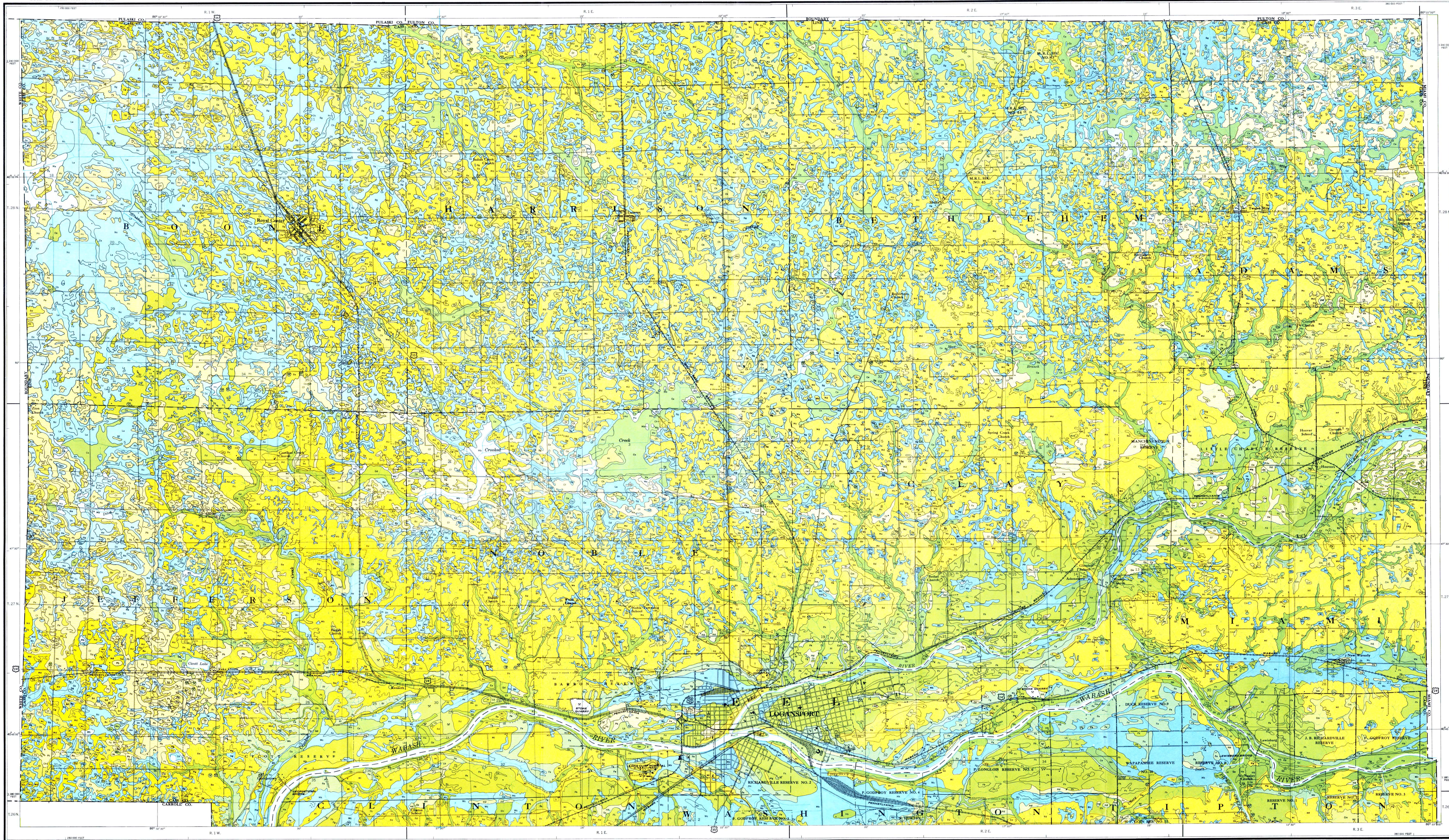
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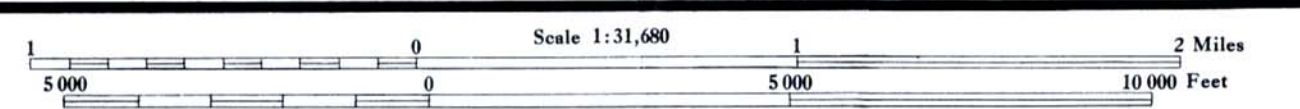
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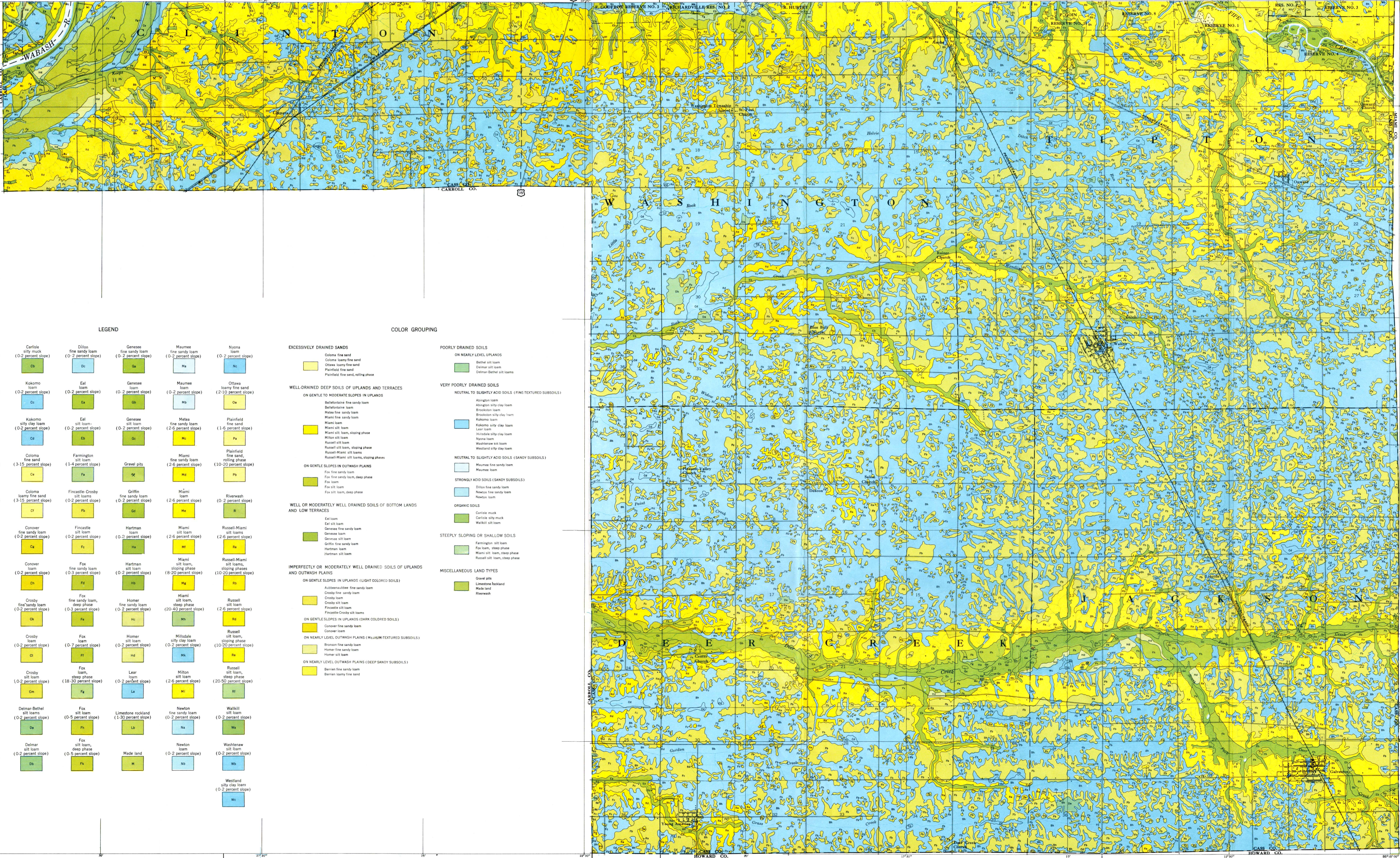
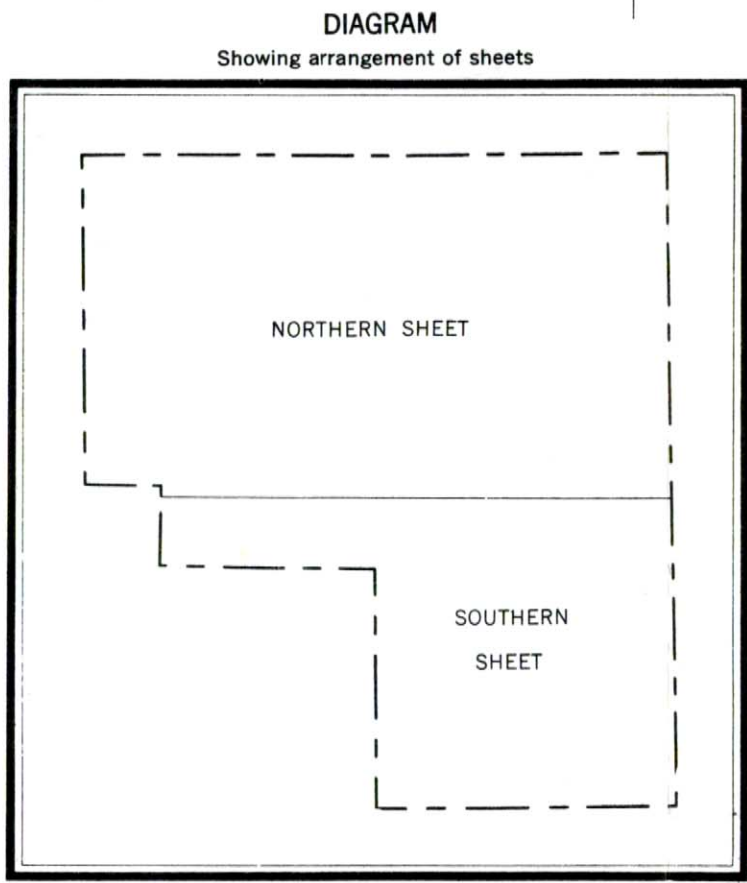
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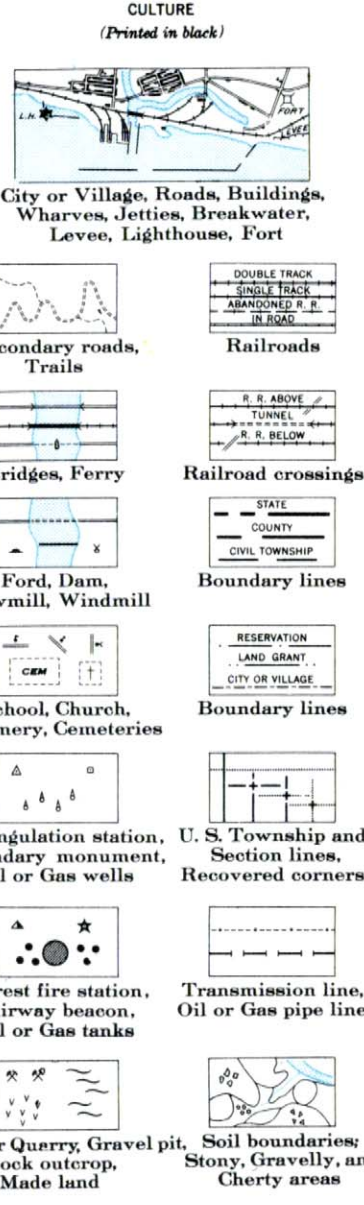
J. Kenneth Alexander, Chief Soil Correlator.
C. P. Barry, Chief Aerials, Soil Use and Productivity.
Earl C. Finner, Principal Soil Correlator, Northern States.
Inspection and correlation by G. C. Rogers, Senior Soil Scientist.
Soils surveyed 1933-38 by N. R. Smith, in charge and W. A. Loughry.
U. S. Department of Agriculture, and D. R. Kuntz,
Purdue University Agricultural Experiment Station.



Map constructed from aerial photographs by
Department of Agriculture, Purdue University, and
Cartographic Division, Soil Conservation Service, USDA.
Polyconic projection, 1927 North American datum.
100,000 foot grid based on Indiana (East) rectangular
coordinate system.



CONVENTIONAL



LEGEND

Abington loam (0-2 percent slope) Aa	Carlisle silt loam (0-2 percent slope) Ca	Dillon fine sandy loam (0-2 percent slope) Da	Genesee fine sandy loam (0-2 percent slope) Ga	Maumee fine sandy loam (0-2 percent slope) Ma	Nyona loam (0-2 percent slope) Na
Abington silty clay loam (0-2 percent slope) Ab	Kokomo loam (0-2 percent slope) Cb	Eal loam (0-2 percent slope) Eb	Genesee loam (0-2 percent slope) Gb	Maumee loam (0-2 percent slope) Mb	Ottawa loamy fine sand (2-10 percent slope) Oa
Auburnsboro fine sandy loam (0-2 percent slope) Ac	Kokomo silty clay loam (0-2 percent slope) Cd	Eal silt loam (0-2 percent slope) Ec	Genesee silt loam (0-2 percent slope) Gc	Metes fine sandy loam (2-6 percent slope) Mc	Plainfield fine sand (1-6 percent slope) Pa
Bellefontaine fine sandy loam (2-10 percent slope) Ba	Coloma fine sand (3-15 percent slope) Ca	Farmington silt loam (1-4 percent slope) Fa	Gravel pits Gp	Miami loam (2-6 percent slope) Ma	Plainfield fine sand, rolling phase (10-20 percent slope) Pb
Bellefontaine loam (2-10 percent slope) Bb	Coloma loamy fine sand (3-15 percent slope) Cl	Fincastle Crosby silt loam (0-2 percent slope) Fc	Griffin fine sandy loam (0-2 percent slope) Gf	Miami silt loam (2-6 percent slope) Mi	Riverwash (0-2 percent slope) Ra
Berrien fine sandy loam (0-3 percent slope) Bc	Conover fine sandy loam (0-2 percent slope) Cc	Fincastle silt loam (0-2 percent slope) Fi	Hartman silt loam (0-2 percent slope) Ha	Miami silt loam, sloping phase (2-6 percent slope) Mf	Russell-Miami silt loam, sloping phase (2-6 percent slope) Rb
Berrien loamy fine sand (0-3 percent slope) Bd	Conover loam (0-2 percent slope) Co	Fox fine sandy loam (0-3 percent slope) Fo	Hartman silt loam (0-2 percent slope) Hb	Miami silt loam, sloping phase (2-6 percent slope) Mg	Russell-Miami silt loam, sloping phase (10-20 percent slope) Rc
Bethel silt loam (0-2 percent slope) Be	Crosby fine sandy loam (0-2 percent slope) Ce	Fox fine sandy loam, steep phase (0-3 percent slope) Fe	Homer fine sandy loam (0-2 percent slope) Ho	Millsdale silt loam (0-2 percent slope) Ml	Russell silt loam, sloping phase (10-20 percent slope) Rd
Bronson fine sandy loam (0-2 percent slope) Br	Crosby silt loam (0-2 percent slope) Cr	Fox loam, steep phase (18-30 percent slope) Fl	Homer silt loam (0-2 percent slope) Hc	Millsdale silt loam, sloping phase (10-20 percent slope) Mn	Russell silt loam, sloping phase (20-50 percent slope) Re
Brookton (0-2 percent slope) Bg	Crosby silt loam (0-2 percent slope) Cm	Fox silt loam (0-5 percent slope) Fs	Lear silt loam (0-2 percent slope) La	Milton silt loam (2-6 percent slope) Ml	Russell silt loam, steep phase (20-50 percent slope) Rf
Brookton silty clay loam (0-2 percent slope) Bh	Delmar-Bethel silt loam (0-2 percent slope) Db	Fox silt loam (0-5 percent slope) Fp	Limestone rockland (1-30 percent slope) Lr	Newton fine sandy loam (0-2 percent slope) Nf	Walkill silt loam (0-2 percent slope) Wb
Carlisle muck (0-2 percent slope) Ca	Delmar silt loam (0-2 percent slope) Dc	Fox silt loam, deep phase (0-5 percent slope) Fa	Made land Ml	Newton loam (0-2 percent slope) Nb	Westland silty clay loam (0-2 percent slope) Wc

COLOR GROUPING

EXCESSIVELY DRAINED SANDS Coloma fine sand Coloma loamy fine sand Ottawa loamy fine sand Plainfield fine sand Plainfield fine sand, rolling phase	WELL-DRAINED DEEP SOILS OF UPLANDS AND TERRACES ON GENTLE TO MODERATE SLOPES IN UPLANDS Bellefontaine fine sandy loam Bellefontaine loam Metes fine sandy loam Brookton silty clay loam Kokomo loam Kokomo silty clay loam Lear loam Nyona loam Westland silty clay loam	POORLY DRAINED SOILS ON NEARLY LEVEL UPLANDS Bethel silt loam Delmar silt loam Delmar-Bethel silt loam
ON GENTLE SLOPES IN UPLANDS (LIGHT COLORED SOILS) Auburnsboro fine sandy loam Crosby fine sandy loam Crosby silt loam Fincastle silt loam Fincastle-Crosby silt loam	ON GENTLE SLOPES IN UPLANDS (DARK COLORED SOILS) Conover fine sandy loam Conover loam	VERY POORLY DRAINED SOILS NEUTRAL TO SLIGHTLY ACID SOILS (FINE-TEXTURED SUBSOILS) Abington loam Abington silty clay loam Brookton loam Brookton silty clay loam Kokomo silty clay loam Lear loam Nyona loam Westland silty clay loam
ON NEARLY LEVEL UPLANDS (MEDIUM-TEXTURED SUBSOILS) Bronson fine sandy loam Homer fine sandy loam Homer silt loam	ON NEARLY LEVEL UPLANDS (DEEP SANDY SUBSOILS) Berrien fine sandy loam Berrien loamy fine sand	NEUTRAL TO SLIGHTLY ACID SOILS (SANDY SUBSOILS) Maumee fine sandy loam Maumee loam
ON GENTLE SLOPES IN UPLANDS (LIGHT COLORED SOILS) Auburnsboro fine sandy loam Crosby fine sandy loam Crosby silt loam Fincastle silt loam Fincastle-Crosby silt loam	ON GENTLE SLOPES IN UPLANDS (DARK COLORED SOILS) Conover fine sandy loam Conover loam	STRONGLY ACID SOILS (SANDY SUBSOILS) Dillon fine sandy loam Newton loam
ON NEARLY LEVEL UPLANDS (MEDIUM-TEXTURED SUBSOILS) Bronson fine sandy loam Homer fine sandy loam Homer silt loam	ON NEARLY LEVEL UPLANDS (DEEP SANDY SUBSOILS) Berrien fine sandy loam Berrien loamy fine sand	ORGANIC SOILS Carlisle muck Carlisle silty muck Walkill silt loam
ON GENTLE SLOPES IN UPLANDS (LIGHT COLORED SOILS) Auburnsboro fine sandy loam Crosby fine sandy loam Crosby silt loam Fincastle silt loam Fincastle-Crosby silt loam	ON GENTLE SLOPES IN UPLANDS (DARK COLORED SOILS) Conover fine sandy loam Conover loam	STEELY SLOPING OR SHALLOW SOILS Farmington silt loam Fox loam, steep phase Miami silt loam, steep phase Russell silt loam, steep phase
ON NEARLY LEVEL UPLANDS (MEDIUM-TEXTURED SUBSOILS) Bronson fine sandy loam Homer fine sandy loam Homer silt loam	ON NEARLY LEVEL UPLANDS (DEEP SANDY SUBSOILS) Berrien fine sandy loam Berrien loamy fine sand	MISCELLANEOUS LAND TYPES Gravel pits Limestone rockland Made land Riverwash

SOILS OF CASS COUNTY, INDIANA: SUMMARY OF IMPORTANT CHARACTERISTICS

Soil ¹	Map symbol	Slope	Parent or underlying material	Topography	Soil drainage ²	Surface runoff	Permeability ³	Color		Susceptibility to erosion under cultivation	General productivity
								Surface soil	Subsoil		
Abington loam	AA	<i>Percent</i> 0-2	Highly calcareous glaciofluvial gravel and sand of Wisconsin age.	Depressions and depressed flats.	Very poorly drained.	Ponded.	Moderate.	Very dark brownish gray to very dark gray.	Gray with some yellow.	Slight to none.	Very high.
Abington silty clay loam	AB	0-2	do.	do.	do.	do.	do.	do.	do.	do.	Do.
Aubbeenaubbee fine sandy loam	AC	0-2	Highly calcareous medium- to light-textured Wisconsin glacial till.	Nearly level to gently undulating.	Imperfectly drained.	Slow.	Moderate to slow.	Brownish gray to light brownish gray.	Mottled gray, yellow, and brown.	Slight.	Low to medium.
Bellefontaine fine sandy loam	BA	2-10	Highly calcareous light-textured Wisconsin glacial drift.	Undulating to sloping.	Somewhat excessively drained.	Moderate to rapid.	Rapid.	Grayish brown to yellowish brown.	Yellowish brown to weak reddish brown.	High.	Do.
Bellefontaine loam	BB	2-10	do.	do.	do.	do.	do.	do.	do.	do.	Medium.
Berrien fine sandy loam	BC	0-3	Noncalcareous, highly siliceous outwash sands.	Nearly level to gently undulating.	Moderately well drained.	Slow.	Very rapid.	do.	Mottled yellow, brown, and gray.	Moderate.	Low.
Berrien loamy fine sand	BD	0-3	do.	do.	do.	do.	do.	do.	do.	do.	Do.
Bethel silt loam	BE	0-2	Highly calcareous medium-textured Wisconsin glacial till.	Nearly level.	Poorly drained.	Very slow.	Slow.	Light gray to gray.	do.	Slight.	Low to medium.
Bronson fine sandy loam	BF	0-2	Highly calcareous glaciofluvial gravel and sand of Wisconsin age.	do.	Moderately well drained.	do.	Rapid to moderate.	Grayish brown.	Pale yellow to brownish yellow.	do.	Medium.
Brookston loam	BG	0-2	Highly calcareous medium-textured Wisconsin glacial till.	Depressions and depressed flats.	Very poorly drained.	Ponded to very slow.	Moderate to slow.	Dark gray to very dark brownish gray.	Mottled gray, yellow, and brown.	do.	Very high.
Brookston silty clay loam	BH	0-2	do.	do.	do.	do.	do.	do.	do.	do.	Do.
Carlisle muck	CA	0-2	Yellow and brown macerated peaty and mucky material.	do.	do.	do.	Rapid.	Very dark brownish gray to black.	Yellow and brown.	Moderate.	Do.
Carlisle silty muck	CB	0-2	do.	do.	do.	do.	do.	do.	do.	do.	Do.
Coloma fine sand	CE	3-15	Loose fine or medium sand over calcareous till.	Undulating to rolling.	Excessively drained.	Slow.	Very rapid.	Yellowish brown to grayish brown.	Brownish yellow or yellowish brown.	Moderate to high.	Low.
Coloma loamy fine sand	CF	3-15	do.	do.	do.	do.	do.	do.	do.	do.	Low to medium.
Conover fine sandy loam	CG	0-2	Highly calcareous light-textured Wisconsin glacial till.	Nearly level.	Imperfectly drained.	do.	Slow to moderate.	Dark brownish gray.	Mottled gray, yellow, and brown.	Slight.	High.
Conover loam	CH	0-2	Highly calcareous Wisconsin glacial till.	do.	do.	do.	do.	do.	do.	do.	Very high.
Crosby fine sandy loam	CK	0-2	do.	do.	do.	do.	do.	Light brownish gray to brownish gray.	do.	do.	Medium.
Crosby loam	CL	0-2	Highly calcareous medium-textured Wisconsin glacial till.	do.	do.	do.	do.	do.	do.	do.	High to medium.
Crosby silt loam	CM	0-2	Highly calcareous medium-textured Wisconsin glacial till.	do.	do.	do.	do.	do.	do.	do.	High.
Delmar silt loam	DB	0-2	do.	do.	Poorly drained.	Very slow.	Slow.	Light gray to gray.	do.	do.	Medium to low.
Delmar-Bethel silt loams	DA	0-2	(⁴)	do.	do.	do.	do.	do.	do.	do.	Do.
Dillon fine sandy loam	DC	0-2	Strongly to medium acid loose outwash sands.	Depressions and depressed flats.	Very poorly drained.	Ponded to very slow.	Very rapid.	Very dark gray to nearly black.	Gray.	do.	Low.
Eel loam	EA	0-2	Neutral to slightly alkaline alluvium from highly calcareous Wisconsin drift.	Nearly level floodplains.	Moderately well to imperfectly drained.	Slow to very slow.	Moderate.	Light yellowish brown to brownish gray.	Mottled gray and yellow.	do.	High.
Eel silt loam	EB	0-2	do.	do.	do.	do.	do.	do.	do.	do.	Do.
Farmington silt loam	FA	1-4	Limestone bedrock.	Nearly level to sloping.	Well drained.	Slow to very rapid.	Moderate.	Dark grayish brown to very dark brown.	Yellowish-brown to very dark brown.	Slight to high.	Low.
Fincastle-Crosby silt loams	FB	0-2	(⁴)	Nearly level to gently undulating.	Imperfectly drained.	Slow.	Slow.	Light brownish gray.	Mottled gray, yellow, and brown.	Slight.	High.
Fincastle silt loam	FC	0-2	Highly calcareous medium- to heavy-textured Wisconsin glacial till overlain by a mantle of silt (loess).	do.	do.	do.	do.	do.	do.	do.	Do.
Fox fine sandy loam	FD	0-3	Highly calcareous glaciofluvial gravel and sand of Wisconsin age.	do.	Well to somewhat excessively drained.	do.	Moderate to rapid.	Grayish brown to light brown.	Weak reddish brown to brown.	do.	Low to medium.
Deep phase	FE	0-3	do.	do.	do.	do.	do.	do.	do.	do.	Medium.
Fox loam	FF	0-7	do.	do.	do.	do.	do.	Grayish brown to brown.	do.	do.	Do.
Steep phase	FG	18-30	do.	Steep.	do.	Rapid.	do.	do.	do.	High.	Very low.
Fox silt loam	FH	0-5	do.	Nearly level to gently undulating.	do.	Slow.	Moderate.	do.	do.	Slight.	Medium to high.
Deep phase	FX	0-5	do.	do.	Well drained.	do.	do.	do.	do.	do.	High.
Genesee fine sandy loam	GA	0-2	Neutral to slightly alkaline alluvium from highly calcareous Wisconsin drift.	Nearly level floodplains.	do.	do.	Moderate to rapid.	do.	Yellowish brown to brown.	do.	Medium.
Genesee loam	GB	0-2	do.	do.	do.	do.	Moderate.	do.	do.	do.	Very high.
Genesee silt loam	GC	0-2	do.	do.	do.	do.	do.	do.	do.	do.	Do.
Griffin fine sandy loam	GD	0-2	do.	do.	Moderately well to imperfectly drained.	do.	Moderate to rapid.	Brownish gray to yellowish brown.	Gray, mottled with brown and yellow.	do.	Low to medium.
Hartman silt loam	HB	0-2	Highly calcareous rock rubble, sand, and gravel of Wisconsin age.	Nearly level.	Well drained.	do.	do.	Grayish brown to brown.	Brown.	Slight.	Medium to high.
Hartman loam	HA	0-2	do.	do.	do.	do.	do.	do.	do.	do.	Medium.
Homer fine sandy loam	HC	0-2	Highly calcareous glaciofluvial gravel and sand of Wisconsin age.	do.	Imperfectly drained.	do.	do.	Brownish gray to light brownish gray.	Mottled gray, yellow, and brown.	do.	Low to medium.
Homer silt loam	HD	0-2	do.	do.	do.	do.	Moderate to slow.	do.	do.	do.	Medium to high.
Kokomo loam	CC	0-2	Highly calcareous Wisconsin glacial till.	Depressions and depressed flats.	Very poorly drained.	Ponded to very slow.	Slow.	Very dark gray to nearly black.	Light-gray to gray with faint light-yellow on brown mottlings in the lower part.	Slight.	Very high.
Kokomo silty clay loam	CD	0-2	do.	do.	do.	do.	do.	do.	do.	do.	Do.
Lear loam	LA	0-2	Highly calcareous poorly assorted glaciofluvial gravel and sand of Wisconsin age with minor quantities of silt and clay.	do.	do.	do.	Moderate to rapid.	Very dark brownish gray to nearly black.	do.	do.	High.
Limestone rockland	LB	1-30	Limestone bedrock.	Nearly level to steep.	Variable.	Slow to rapid.	Variable.	Gray (bedrock).	Gray (bedrock).	Slight to high.	Very low.
Made land	M										
Maumee fine sandy loam	MA	0-2	Calcareous glaciofluvial loose sands.	Depressions and depressed flats.	Very poorly drained.	Ponded to very slow.	Rapid.	Very dark gray to nearly black.	Gray.	Slight to moderate.	Medium.
Maumee loam	MB	0-2	do.	do.	do.	do.	do.	do.	do.	Slight.	Medium to high.
Metea fine sandy loam	MC	2-6	Highly calcareous light-textured Wisconsin glacial till.	Undulating to gently rolling.	Good to somewhat excessively drained.	Medium.	Moderate to rapid.	Grayish brown to light yellowish brown.	Yellowish brown to brownish yellow.	Moderate to high.	Medium.
Miami fine sandy loam	MD	2-6	do.	Undulating to gently sloping.	Well drained.	Medium to rapid.	Moderate.	do.	do.	do.	Do.
Miami loam	ME	2-6	Highly calcareous Wisconsin glacial till.	do.	do.	do.	do.	do.	do.	do.	High.
Miami silt loam	MF	2-6	Highly calcareous Wisconsin glacial till.	do.	do.	do.	do.	do.	do.	do.	Do.
Sloping phase	MG	8-20	do.	Sloping to strongly sloping.	Well to somewhat excessively drained.	Rapid to very rapid.	do.	do.	do.	High.	Medium.
Steep phase	MH	20-40	do.	Steep.	Excessively drained.	Very rapid.	do.	do.	do.	Very high.	Low.
Millsdale silty clay loam	MX	0-2	Limestone bedrock.	Depressions and depressed flats.	Very poorly drained.	Ponded to very slow.	Slow.	Very dark brownish gray to nearly black.	Gray or mottled gray and yellow.	Slight.	High to very high.
Milton silt loam	ML	2-6	do.	Nearly level to gently sloping.	Well drained.	Slow to medium.	Moderate.	Grayish brown to brown.	Yellowish brown to brown.	Slight to moderate.	High.
Newton fine sandy loam	NA	0-2	Strongly to medium acid loose outwash sands.	Depressions and depressed flats.	Very poorly drained.	Ponded to very slow.	Rapid.	Very dark brownish gray to very dark gray.	Mottled gray, yellow, and brown.	Slight.	Very low.
Newton loam	NB	0-2	do.	do.	do.	do.	do.	do.	do.	do.	Do.
Nyona loam	NC	0-2	Highly calcareous poorly assorted glaciofluvial gravel, sand, and some silt and clay of Wisconsin age.	do.	do.	do.	Moderate to rapid.	do.	do.	do.	High to very high.
Ottawa loamy fine sand	OA	2-10	Medium acid loose sand over calcareous clay.	Undulating to rolling.	Excessively drained.	Slow.	Very rapid.	Grayish brown to light yellowish brown.	Brownish yellow.	Slight to high.	Low.
Plainfield fine sand	PA	1-6	Strongly acid loose sands.	Nearly level to undulating.	do.	do.	do.	do.	Brownish yellow to pale yellow.	Moderate to high.	Very low.
Rolling phase	PB	10-20	do.	Rolling.	do.	do.	do.	do.	do.	do.	Do.
Riverwash	R	0-2	Calcareous gravel, sand, rocks, and boulders.	Nearly level.	Variable.	Variable.	do.	Gray and light yellow.	Gray and light yellow.	Variable.	Do.
Russell silt loam	RD	2-6	Highly calcareous medium- to heavy - textured Wisconsin glacial till with a thin covering of silt.	Undulating to gently rolling.	Well drained.	Medium.	Moderate.	Grayish brown to light yellowish brown.	Brownish yellow to yellowish brown.	Moderate to high.	High.
Sloping phase	RE	10-20	do.	Sloping.	do.	Rapid.	do.	do.	do.	High.	Medium.
Steep phase	RF	20-50	do.	Steep.	Excessively drained.	Very rapid.	do.	do.	do.	Very high.	Low.
Russell-Miami silt loams	RA	2-6	(⁴)	Undulating to gently sloping.	Well drained.	Medium.	do.	do.	do.	Variable.	High.
Sloping phase	RB	10-20	(⁴)	Sloping.	do.	Rapid.	do.	do.	do.	High.	Medium.
Walkill silt loam	WA	0-2	Yellow and brown macerated peaty and mucky materials.	Depressions and depressed flats.	Very poorly drained.	Ponded to very slow.	do.	Grayish brown to brownish gray.	Brownish gray to very dark gray.	Slight.	High to very high.
Washtenaw silt loam	WB	0-2	Highly calcareous light- to heavy-textured Wisconsin glacial till.	do.	do.	do.	Moderate to slow.	do.	Brownish gray.	do.	Do.
Westland silty clay loam	WC	0-2	Highly calcareous glaciofluvial gravel and sand of Wisconsin age.	do.	do.	do.	Slow.	Dark gray to very dark brownish gray.	Mottled gray, yellow, and brown.	do.	Very high.

¹ In addition gravel pits.

² Natural drainage conditions under which the soil developed before artificial drainage was installed.

³ Capacity of soils to allow water to move through the profile in the absence of a water table.

⁴ See description of each soil.

TABLE 10.—*Use and management suggestions for soils of Cass County, Ind.*

[All mineral soils need additions of nitrogen, phosphorus, and potassium. The grades and quantities of fertilizers used should be based on a consideration of the available soil supply of these nutrients, the cropping history, past fertilizer practices, quantity of manure used, and crops to be grown. A shortage of one or more nutrient elements often restricts yields to low levels. On the other hand, a liberal supply of plant nutrients along with other favorable conditions, including good moisture supply and soil tilth, makes high yields possible. The figures given in the table for fertilizer applications are intended only as a guide under favorable cost-price relationships; even larger amounts than those suggested under superior management may be profitable.]

LIGHT-COLORED MINERAL SOILS OF UPLANDS AND TERRACES

Management group and subgroup and soil type or phase	Dominant slope range	Predominant soil problems	Crop suitability	Suitable rotations ¹			Lime requirement on unlimed land ²	Fertilization ³						Other soil management practices needed and remarks
				Without special conservation practices	With contour tillage	With contour tillage and stripcropping		Average management (pounds per acre per year)			Superior management (pounds per acre per year)			
								N	P ₂ O ₅	K ₂ O	N	P ₂ O ₅	K ₂ O	
Management group 1—Well-drained medium-textured soils: Subgroup 1A: Soils with gentle slopes: Miami loam..... Miami silt loam..... Russell silt loam..... Russell-Miami silt loams..... Milton silt loam..... Subgroup 1B: Soils with moderate slopes: Miami silt loam, sloping phase..... Russell silt loam, sloping phase..... Russell-Miami silt loams, sloping phases..... Subgroup 1C: Soils with steep slopes: Miami silt loam, steep phase..... Russell silt loam, steep phase..... Fox loam, steep phase..... Subgroup 1D: Soils shallow to bedrock: Farmington silt loam..... Limestone rockland..... Management group 2—Moderately well drained to somewhat excessively drained medium and moderately coarse textured soils: Subgroup 2A: Nearly level medium-textured soils: Fox loam..... Fox silt loam..... Fox silt loam, deep phase..... Hartman silt loam..... Hartman loam..... Subgroup 2B: Nearly level moderately coarse textured soils: Bronson fine sandy loam..... Fox fine sandy loam..... Fox fine sandy loam, deep phase..... Subgroup 2C: Moderately sloping medium and moderately coarse textured soils: Bellefontaine loam..... Bellefontaine fine sandy loam..... Miami fine sandy loam..... Metea fine sandy loam..... Management group 3—Excessively drained coarse-textured soils: Coloma fine sand..... Coloma loamy fine sand..... Ottawa loamy fine sand..... Plainfield fine sand..... Plainfield fine sand, rolling phase..... Management group 4—Moderately well drained coarse and moderately coarse textured soils: Berrien fine sandy loam..... Berrien loamy fine sand..... Management group 5—Imperfectly drained medium and moderately coarse textured soils: Subgroup 5A: Medium-textured soils: Conover loam..... Crosby loam..... Crosby silt loam..... Fincastle silt loam..... Fincastle-Crosby silt loams..... Homer silt loam..... Subgroup 5B: Moderately coarse textured soils: Aubbeenaubee fine sandy loam..... Crosby fine sandy loam..... Conover fine sandy loam..... Homer fine sandy loam..... Management group 6—Poorly drained medium-textured soils: Bethel silt loam..... Delmar silt loam..... Delmar-Bethel silt loams.....	Percent 2-6 2-6 2-6 2-6 2-6 8-20 10-20 10-20 20-40 20-50 18-30 1-4 1-30 0-7 0-5 0-5 0-2 0-2 0-3 0-3 2-10 2-10 2-6 2-6 3-15 3-15 2-10 1-6 10-20 0-3 0-3 0-2 0-2 0-2 0-2 0-2 0-2 0-2 0-2 0-2 0-2 0-2 0-2 0-2 0-2	Erosion hazard..... <												

DARK-COLORED MINERAL SOILS OF UPLANDS AND TERRACES

Management group 7—Very poorly drained slightly acid to neutral soils of the depressional areas underlain by clayey materials:																		
Brookston loam.....	0-2	} Drainage.....	General crops of area; suitable for intensive row cropping.	C-C-G (Sc) C-B-G-M-C-G (Sc) C-B-G-M C-G-M	(9).....	(9).....	0	0 on 1st year corn, 40 on 2nd year corn, 20 on wheat.	25	25	40 on 1st year corn, 80 on 2nd year corn, 20 on wheat.	25	35	Water on surface may result in winterkilling of alfalfa or wheat in some areas of Kokomo may be seriously deficient in K.				
Brookston silty clay loam.....	0-2																	
Kokomo loam.....	0-2																	
Kokomo silty clay loam.....	0-2																	
Millsdale silty clay loam.....	0-2																	
Washtenaw silt loam.....	0-2																	
Management group 8—Very poorly drained slightly acid to neutral soils of the depressional areas underlain by stratified gravel and loamy materials:																		
Abington loam.....	0-2	} ..do.....	..do.....	C-B-G (Sc) C-B-G-M C-B-G-M-C-G (Sc)	(9).....	(9).....	0	20	25	40 on corn, 20 on wheat.	25	45	Do.				
Abington silty clay loam.....	0-2																	
Lear loam.....	0-2																	
Maumee fine sandy loam.....	0-2																	
Maumee loam.....	0-2																	
Nyona loam.....	0-2																	
Westland silty clay loam.....	0-2																	
Management group 9—Very poorly drained strongly acid soils of the terraces underlain by stratified sand:																		
Dillon fine sandy loam.....	0-2	} Drainage; high acidity; low fertility.	General crops; alfalfa and sweetclover are poorly suited.	C-B-G-M	(9).....	(9).....	3-4	20 on small grain.....	20	20	50 on corn, 20 on small grain.	25	35	Drainage needed that will remove surplus water in spring and control water level during summer.				
Newton fine sandy loam.....	0-2																	
Newton loam.....	0-2																	

ORGANIC SOILS

[illegible]

SOILS OF THE BOTTOM LANDS

Management group 11—Well-drained soils of the bottom lands:														
Genesee fine sandy loam.....	0-2	} Stream overflow.....	Suited for intensive row crop culture; fall-seeded grain is poorly suited.	C-C-C C-C-G (Se) V-C-G (Sc)	(9).....	(9).....	0	50 on corn.....	20	20	80 on corn.....	30	30	Levee protection needed on large bottoms; crop rotations to aid weed control.
Genesee loam.....	0-2													
Genesee silt loam.....	0-2													
Management group 12—Moderately well drained and imperfectly drained soils of the bottom lands:														
Eel loam.....	0-2	}do.....	Same as group 11 and permanent pasture.	C-C-C C-B-G (Se) O-C-G (Sc)	(9).....	(9).....	0		20	20	40 on corn.....	30	30	Do.
Eel silt loam.....	0-2													
Griffin fine sandy loam.....	0-2													

¹ Abbreviations are C=corn; B=soybeans; G=small grain (oats, wheat, rye, barley); O=oats; W=wheat; R=rye; M=meadow including one or more of the following grasses and legumes: Alfalfa, red clover, timothy, ladino clover; A-B=alfalfa-bromegrass meadow mixture; V=vegetable crop, such as onion, potatoes, carrots, tomatoes, celery, and sweet corn; (Sc)=sweetclover catch crop. Corn may be substituted for soybeans in these rotations. The first rotation listed for each management group is the most intensive one suitable under the conditions indicated. Other rotations of equal or less intensity may be chosen from those that follow in the list or from the rotations given on page 97.

² Range in amount of limestone probably needed; test before lining. If coarse grades of limestone are applied, use 50 percent more than test indicates.

Fertilizer recommendations are based on pounds of nitrogen (N), available phosphorus (P_2O_5), and water soluble potash (K_2O) per acre annually required for the first rotation listed for each management group. Under superior management when yields are low and soil tests indicate fertility is low, heavy applications of 10-10-10 or 0-20-20 should be plowed down in addition to the treatments recommended. See page 97 for sample calculation of fertilizer program for a specific soil.

⁴ Not suitable for crop rotations.

^b Do not require the conservation practices shown in the column headings.